THE DECEMBER SCIENTIFIC MONTHLY

Edited by

J. McKEEN CATTELL, F. R. MOULTON AND WARE CATTELL

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NEW BOOKS OF SCIENTIFIC INTEREST

Earth, Moon and Planets. F. L. WHIPPLE. Illustrated. vi + 293 pp. $2.50. October, 1941. Blakiston.

Information about the moon and the planets, their origin, evolution and atmospheres and the possibilities of life outside the earth are discussed in this little volume in non-technical language. A "Planet Finder and Star Chart" is included.

Biography of the Earth. G. GAMOW. Illustrated. xiii + 242 pp. $3.00. 1941. Viking.

A professor of theoretical physics describes in a popular manner the age of the earth, the origin of the moon and the planets, a "journey" to the center of the earth, mountains, continents, the climates of the past, and the development of life, ending with the chapter "A Glimpse into the Future."

Time and Timekeepers. W. I. MILHAM. 3rd ed. Illustrated. xix + 616 pp. $1.98. October, 1941. Macmillan.

The whole subject of Time from the beginnings of history is covered in this book. After a chapter on Time in general, the history of timekeepers is traced from the primitive sundials to modern clocks and watches, including their construction, care and accuracy.

Glass: The Miracle Maker. C. J. PHILLIPS. Illustrated. xii + 424 pp. $4.50. 1941. Pitman.

The story of the history, manufacture, physical and chemical properties of glass and its applications are here collected from scattered sources. It is intended for the architect, engineer, industrial designer and layman who are interested in glass and its future possibilities in industry.

Biology and Human Affairs. J. W. RITCHIE. Illustrated. xiv + 1026 pp. $2.32. 1941. World Book.

This textbook for a high school biology course is intended to develop an appreciation of the method and scope of biology and the importance of extending its application to human affairs. The presentation combines the type, group and principles methods.

Biological Symposia. Volume III. W. O. FENN, editor. ix + 370 pp. $3.50. 1941. Jaques Cattell.

This volume on muscle physiology is a collection of papers given at a symposium on muscle of the American Physiological Society, together with additional papers. Muscle chemistry and myoneural transmission, eliminated from the symposium, are included.

Desert Wild Flowers. E. C. JAEGER. 2nd ed. Illustrated. xxx + 322 pp. $3.50. October, 1941. Stanford.

Following a key to identification are descriptions which stress the natural history of 764 desert plants. The volume is illustrated with photographs and drawings by the author. It is a field reference for the amateur as well as for the professional botanist.

Endocrinology. R. G. HOSKINS. Illustrated. 38x pp. $4.00. 1941. Norton.

A discussion of the glands and their functions as they are known today, describing hormone secretions and their influence on human life. It is intended for the doctor and intelligent layman as well as for students of psychology and medicine, being based on the author's earlier book, "Tides of Life."

Hippocratic Medicine. W. A. HEIDEL. Illustrated. xv + 149 pp. $2.00. September, 1941. Columbia.

This discussion pictures Hippocrates, the "Father of Medicine," as a typical physician of his day. It is concerned chiefly with the spirit and methods of the Greeks, aiming to interest the physician and not to solve literary or historical problems.

Native African Medicine. G. W. HARLEY. Illustrated. xvi + 294 pp. $3.50. 1941. Harvard.

A medical missionary presents the results of a study of the medicinal practices of African natives, with special reference to the Mano tribe of Liberia. All native herbal remedies for illness or of supposedly magic portent are discussed, accompanied by a description of any ceremonials connected with them.

Human Anatomy and Physiology. N. D. MILLARD and B. G. KING. Illustrated. vii + 525 pp. $3.00. 1941. Saunders.

This textbook for a student nurse course in human anatomy and physiology is organized in five major functional units, each with an anatomical system as its basis. The structure of the system is described first, followed by a discussion of its physiology.

The Living Past. C. H. GORDON. Illustrated. 232 pp. $2.50. 1941. John Day.

Though this is a popular study of what the archaeologist does and what he finds, it has been prepared for the specialist as well as for the layman. The author has chosen Western Asia as his scene, and many anecdotes of his personal experiences with the Arabs now living there are included.

Rubber's Goodyear. A. C. REGLI. Illustrated. viii + 248 pp. $2.50. 1941. Messner.

This biography of Charles Goodyear is the story of his discovery of the rubber vulcanizing process and his perseverance in making the world realize its utility. It tells of his reverses, his final success and of the many court trials he was forced to carry out concerning infringements on his patents.

The South Seas in the Modern World. F. M. KEESING. Illustrated. xv + 391 pp. $3.50. 1941. John Day.

A survey of the Oceanic islands of the Pacific, this volume discusses their political, strategic, and economic role and the problems of the natives in the world today. The author is professor of anthropology at the University of Hawaii.

THE SCIENTIFIC MONTHLY

DECEMBER, 1941

DETERMINISM IN PRIMITIVE SOCIETY?

By Dr. JULIAN H. STEWARD

SENIOR ANTHROPOLOGIST, BUREAU OF AMERICAN ETHNOLOGY

THERE has recently been renewed interest in the general proposition, stated in many ways and with varying degrees of moderation, that technological and economic changes largely predetermine social and political trends. Politicians, business men and laymen argue the power of some form of "economic determinism" as against ideologies. What has anthropology, centering its attention largely on the simpler peoples of the world where it should be easier to isolate the causes of social change, to say of this proposition?

Anthropologists have long recognized that the spread of customs from one group of people to another—"diffusion" in anthropological terminology—accounts for at least nine tenths of the culture of any group. On its face, this would seem to assign any kind of economic determinism an insignificant role. An analysis of this problem, however, in the light of what is known of culture change among primitive peoples, both before and after they have experienced acculturation resulting from contact with European cultures, exposes its considerable complexity. Under certain conditions, subsistence patterns—that is, the activities concerned with acquiring food, clothing, shelter and other things indispensable to existence—have imposed very narrow limits on possible variation of social and economic organization. Under other conditions, it is evident that considerable latitude is possible in the socio-economic structure. Before attempting any generalizations, therefore, anthropology is compelled to ascertain in specific circumstances the manner and extent to which subsistence patterns have affected the total culture.

Subsistence patterns have been extraordinarily potent in shaping the social organization of a number of primitive hunting and gathering peoples in different parts of the world. Among the Bushmen, African and Malaysian Negritos, Australians, Tasmanians, Fuegians, southern California Indians, and several others certain features of the relationship of man to his environment are very similar and have produced almost identical social patterns. All these peoples live in areas of slim food resources and low population density. To obtain adequate food, it is necessary that single families forage alone during most of the year. Larger population aggregates are possible only for brief periods of abundance when a few communal enterprises are carried on. Because hunting provides the most important food, it is customary for a man to remain in the territory in which he has been raised and has learned to know intimately. He hunts alone or with a few other men who do not venture beyond their territory and defend it from trespass by outsiders.

MOUNT ROCHER DEBOULE RISES ABOVE BULKLEY RIVER

WESTERN SLOPE HABITAT OF THE CARRIER INDIANS. THE RIVER IS AN IMPORTANT SOURCE OF SALMON.

As the local group rarely numbers more than 50 people, its members are usually related so that it is necessary that a man take his wife from another group. Each group consequently consists of people related through the male line. It is a patrilineal, patrilocal, exogamous, land-owning band. This pattern is repeated so consistently under identical economic and environmental conditions that a cause-and-effect relationship between the latter and the former is unmistakable.[1]

Although the essential social patterns of the tribes just mentioned developed directly from factors that are mainly economic, diffusion was also at work in some cases. In northern Australia, matrilineal moieties—dual divisions reckoning descent through the female line—had spread among many tribes and been superimposed on patrilineal bands to create a complicated system of marriage classes. In southern California patrilineal moieties had been adopted by several tribes with patrilineal bands. And among all these tribes, a number of minor details of society were clearly derived from neighboring areas.

Subsistence patterns imposed even narrower limits on the social structure of Shoshonean tribes in the Great Basin area of the western United States.[2] In aboriginal days, the Shoshoneans did little hunting, as game was too scarce. They relied predominantly on wild seeds that grow sparsely in the semi-deserts. Because these seeds occur somewhat erratically from year to year it was necessary that families, usually wandering alone in their food quest, gather seeds wherever they could be found. This brought overlapping subsistence areas and a complete lack of ownership of natural resources. The lone family, therefore, was usually the maximum economic unit and, rarely enjoying the company of other families, it was the only stable social unit, being linked to other families only through loose kinship bonds.

But the entire socio-economic structure of certain Shoshoneans was altered by a single factor introduced by the White man. The horse was adopted at an early date by those groups occupying grass-

OLD TSIMSHIAN HOUSE

EXTERIOR AND INTERIOR. BUILT OF HAND HEWN BOARDS TIED WITH WITHES. IT WILL SOON BE A SUBJECT FOR THE ARCHEOLOGIST.

lands. The transportational advantages of the horse not only enhanced the importance of hunting among those near bison country, but enabled considerable numbers of people to live together in permanet association. It was no longer necessary that families remain near their stored foods in various parts of the country; food could be transported to a central point. These Shoshoneans

[1] Julian H. Steward, "The Social and Economic Basis of Primitive Bands." In "Essays in Anthropology in Honor of Alfred L. Kroeber," Berkeley, California, 1936, pp. 331–350.

[2] SCIENTIFIC MONTHLY, 49: 524–537, December, 1939.

A FORT ST. JAMES CARRIER FAMILY AT LUNCH IN THE FRONT YARD

quickly developed bands of considerable size.

The question of what limitation subsistence patterns imposed on the social structure of hunters and gatherers in a more fertile environment was investigated among the Carrier Indians of British Columbia. The Carrier Indians

CARRIER INDIANS AT FORT ST. JAMES, BRITISH COLUMBIA
MAKE MANY BIRCHBARK VESSELS FOR HOME USE AND FOR SALE

inhabit an area of comparatively abundant food resources. Like their Athapaskan-speaking relatives of the Mackenzie basin, they trapped fur-bearing animals and hunted large game characteristic of the north woods. But, like the tribes of the north Pacific coast, they also took considerable quantities of fish, especially salmon, from the headwaters of the Fraser and Skeena Rivers. Although less wealthy than the coast Indians, the Carrier found living not as precarious as among the tribes east of the Continental Divide beyond the habitat of the salmon.

COWBOY JIG CONTEST AT THE ANNUAL STONEY CREEK CARRIER STAMPEDE
A GUITAR AND ACCORDION SUPPLY MUSIC.

The history of the Carrier Indians is known in considerable detail during the century and a quarter that has elapsed since the first European visited them in 1805. Certain events during the prehistoric period can be inferred with reasonable certainty.

The Carrier subsistence pattern that was known at the beginning of the historic period probably extends back several centuries. It rested on a balance of complementary activities carried on during the summer and winter, respectively. In summer, people remained in permanent villages near their fisheries and caught great quantities of salmon. Communal enterprises, such as the construction of fish weirs, contributed to group solidarity. In late fall, when furs were prime, families, alone or in small groups, took to the streams and forests to trap beaver, muskrat, mink, fox and other fur-bearing animals and to hunt deer, bear and caribou. They remained, however, within easy distance of their villages because hunger compelled them to return home from time to time to their stores of smoked salmon.

Carrier socio-economic organization must originally have been based on some kind of loose bands like those of the interior Athapaskans. If the Carrier were distinctive, it was probably because salmon gave them greater security and permitted permanent villages, whereas Athapaskans beyond the salmon habitat had to wander over their hunting lands throughout the year. There is no reason to believe that the Carrier had any kind

of private ownership of food resources. As among other Athapaskans, all members of the village or band probably had the right of using the group's fishing stations and hunting area.

In the course of time, however, the Carrier were exposed to influence from the Pacific coast, where the tribes had a strongly matrilineal society with an aristocracy based on wealth—a socio-economic organization unique among American Indians. The Northwest Coast tribes are organized in totemic moieties and clans. A child belongs by birth to his mother's group. Each clan and moiety had certain hereditary titles of nobility which were held by individual men and passed on to their sisters' sons, thus remaining in the clan and family. With these titles went rights to the produce of certain fisheries and other natural resources and the privilege of requiring one's clansmen of the common class to help amass goods for great feasts at which presents were distributed to rival chiefs or nobles. These feasts, called potlatches, were essential to establish a title and the wealth it represented, for the Northwest Coast point of view held that proof of wealth lay in distributing rather than hoarding goods.

COMPLICATED DEADFALL TRAPS
FORMERLY USED BY THE CARRIER INDIAN FOR CATCHING FUR-BEARING ANIMALS.

Completely foreign to Athapaskan society as this Northwest Coast pattern would seem, it spread up the Skeena River from the Tsimshian Indians to the Carrier of Babine Lake and finally to those of Stuart Lake. Its appearance among the Carrier, however, was in comparatively late prehistoric times, for it was still spreading when the White man arrived. Some Carrier adopted it only within the past hundred years. The Stuart Lake people, however, had the whole system when the Europeans first arrived as several facts show. The succession of matrilineally inherited land and titles can be traced back to this time. Moreover, several historic incidents demonstrate the importance of wealth to the early Carrier. It is related that in 1823 James Douglas, who was in charge of Fort St. James, had two Indians put to death for the murder of two soldiers. The great chief Kwah entered the fort to avenge the matter. He objected not to the death sentence imposed on the Indians but to their bodies having been thrown to dogs. As Kwah threatened to kill Douglas, a quick-thinking woman began to potlatch him with tobacco, blankets and other goods thrown from the loft. No Carrier nobleman could

commit murder in the face of such gifts and Douglas's life was spared.

So far as can be ascertained, the transition from a simple band system to the Northwest Coast type of society occurred without a single important change in the methods of producing wealth. Hunting, fishing and fur-trapping were still carried on with devices that are widespread and clearly old in the north—bows and arrows, traps, nets and snares. Innovations were not in methods of production but in ownership and distribution. Land that previously had belonged to the whole group was now divided among men holding potlatch titles. Other people continued to live on the produce of this land but might be obliged to supply the needs of their potlatching nobleman, who might also be a kinsman and a source of some pride to them. In short, wealth was now owned and much of it consumed by a hereditary aristocracy.

The only economic factor that must be considered in this new Carrier social order was salmon fishing. The wealth that salmon made possible was insufficient to create a new system, but without it the system could not have been introduced. This is shown by the distribution of clans and potlatching. Whereas they were finally adopted by practically all the tribes on the salmon streams west of the Continental Divide in northern British Columbia, they did not and almost certainly could not have spread to the poorer Athapaskans of the Mackenzie basin beyond the habitat of the salmon.

The first effect of contact with the White man was to intensify rather than alter the motivations and structure of Carrier society. Steel traps made it possible to take more furs, guns to shoot more game and steel tools to construct weirs that would catch more salmon. The fur-trade introduced a wealth of European goods. Potlatch guests enjoyed presents in greater variety and quantity than ever. But at best, Carrier

CARRIER NONAGENARIAN
AT FORT ST. JAMES AGES ARE KNOWN THROUGH CHURCH RECORDS.

potlatches were sorry affairs compared with those held by Indians on the coast, where natural resources are far greater. A wealthy coast noble might not only distribute quantities of food, hundreds of Hudson's Bay blankets, and other presents, but, to prove that his wealth was unlimited, kill a slave or burn a canoe in sheer bravado. A potlatching Carrier gave each guest a bit of food, perhaps a pair of moccasins or leggings, and a quarter or a sixth of a Hudson's Bay blanket. It was said that a man who had been potlatched often might receive enough pieces of blanket to sew them together into a whole blanket!

In the course of time, other influences emanating from the White man began to undermine the native Carrier system. But the transition to a new kind of society was effected gradually, through a series of cultural reintegrations. The Carrier experienced a minimum of the shock that has demoralized so many

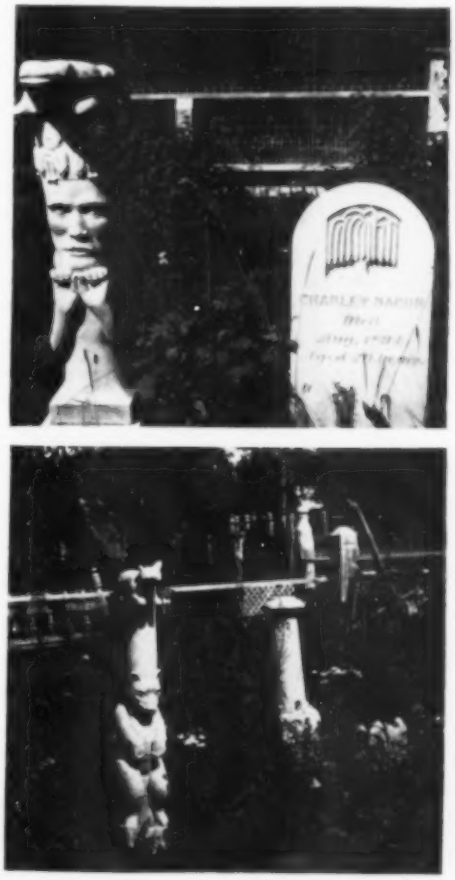
THE BULKLEY AND BABINE RIVERS, FLOWING OUT OF CARRIER TERRITORY JOIN AT HAZLETON TO FORM THE SKEENA RIVER IN TSIMSHIAN COUNTRY.

THE LOWER SKEENA RIVER, ONE OF THE MAIN SALMON STREAMS IN BRITISH COLUMBIA. IT FLOWS THROUGH MOUNTAIN RANGES SCULPTURED BY HUGE GLACIERS THAT DESCEND NEARLY TO THE SEA LEVEL.

Indian tribes after the impact of European culture on their own. Some of the ease with which change was accomplished may be attributed to the powerful personality of Father Morice, a Catholic missionary among them during the crucial years of their transformation. An historian and ethnographer, Father Morice studied the native Carrier culture and succeeded not only in stamping out many features disapproved by the Church but in developing the Carrier along new lines.

One of the first blows at the native system was to disrupt the mechanism for inheriting wealth and titles by banning cross-cousin marriage. It had been the custom that a man marry his mother's brother's daughter, live for some years in his uncle's household, and finally inherit his uncle's land and title. With a prohibition on cousin marriage, this inheritance machinery was thrown out of gear. It was still possible, of course, for a man to give his wealth and titles to his sister's son, but, without cross-cousin marriage, his own daughter received nothing, so that these were alienated from his immediate family. Moreover, the Carrier were continually exposed to the White man's system of patrilineal ownership and inheritance. In the course of time, therefore, certain men came to consider it better to divide their estates among their own sons and repudiate the ancient obligation to give them to their nephews. One of the first to follow this independent course was Chief Kwah, owner of the highest titles and largest territory at Fort St. James. He divided his land equally among all his sons. An increasing number of men followed Kwah's example so that to-day very few Carrier families lack trapping grounds Descent from father to son is the rule.

The new system of land tenure and inheritance in turn destroyed the basis of the old titles and potlatching. For a few years, men continued to pass their titles to their nephews even while giving their land to their own sons. But a title is worthless unless a potlatch feast can be held to establish it, and a potlatch can not be given without ample resources. Potlatching therefore was doomed and titles were empty. One of



TSIMSHIAN GRAVE STONES

IN THE HAZLETON CEMETERY SHOW A MIXTURE OF CHRISTIANITY AND TOTEMISM. FROM WOODEN MODELS CARVED BY INDIANS, PROFESSIONAL STONE CUTTERS REPRODUCE THESE IN MARBLE.

Kwah's sons attempted to usurp Kwah's title which, by the former rule, should have gone to the nephew. This not only violated native usage but, having little wealth, Kwah's son was unable to pot-

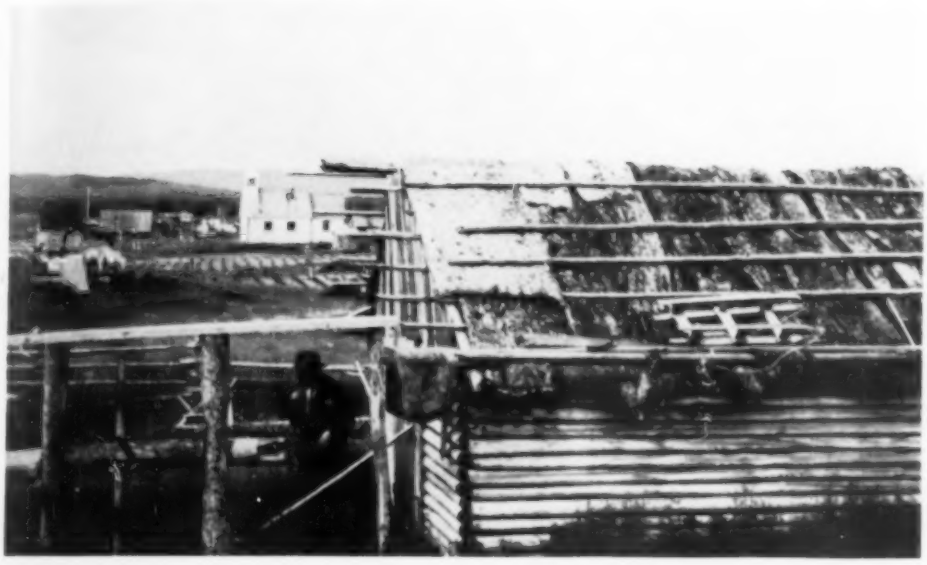
latch for his title. He was refused recognition. To-day most Stuart Lake Carrier not only do not know who would be eligible for titles but have forgotten what most of the titles were.

Potlatching was also undermined when the Indians began to learn that it is better to husband goods than to give them away. The importance of this became very clear after the fur take had begun seriously to decline as a result of immoderate trapping with steel traps and after the salmon catch had all but vanished when the government prohibited the use of weirs and when the down-stream canneries cut heavily into each salmon run. Under aboriginal conditions, depleted fortunes could have been restored in time with hard work. Now, with reduced resources, potlatching ate into capital that would take many years to replenish and tended to pauperize the common people who had to supply potlatch goods. In a few parts of British Columbia where secret potlatches are occasionally held to-day in defiance of Provincial law, public officials are no little annoyed that commoners who have impoverished themselves for potlatches should clamor for government relief!

Among the last features of the old Carrier social system to fade were the matrilineal, exogamous clans. These could, of course, have persisted after potlatching was abandoned. But they were weakened when the Indians accepted Catholicism. The clans had consisted of people who felt themselves related to one another because they had the common bond of an animal totem as well as economic functions. When the Catholic Church destroyed the system of myths and beliefs that had sanctioned the supernatural nature of these totems, the bond between clansmen was greatly weakened. The sense of kinship began to fade and marriages between clan members became more frequent.

Present-day Carrier society at Stuart Lake consists of individual families that

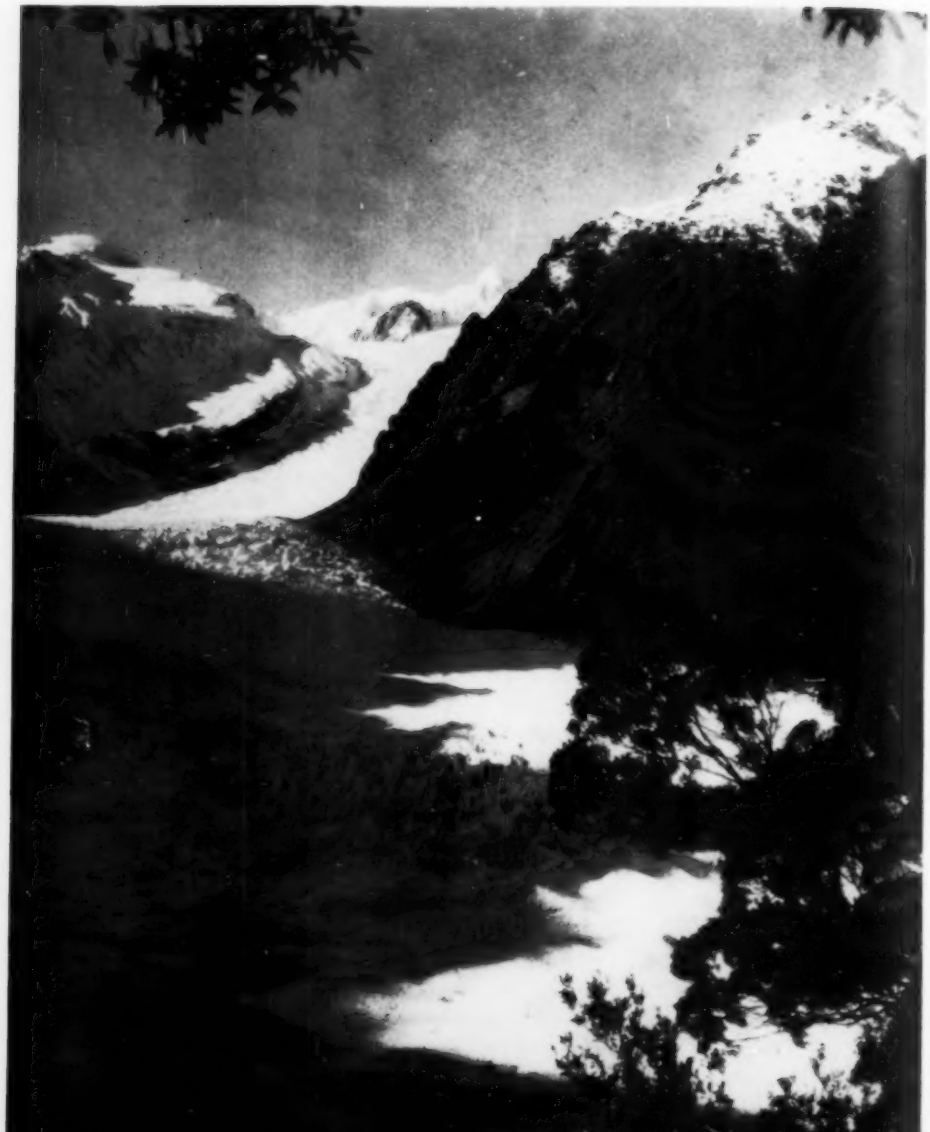
CARRIER WOMAN AND DAUGHTER-IN-LAW



SMOKE HOUSE FOR DRIED FISH AND MEAT WITH NATIVE TYPE BARK ROOF

have exclusive rights to certain traplines that are registered with and protected by the Provincial Government. The family is the kinship and economic unit. Potlatching, status based on wealth and exogamous clans have disappeared. The transition to the new socio-economic system was caused mainly by non-economic factors—absorption of the White man's ideology, especially Catholicism. Depletion of native resources was only an incidental, contributing factor. Its effect will probably be consummated in the future, when the native economy gradually gives place to a system of jobs and wages and the Carrier are absorpted in the broader economy of the White man.

From this review, it is evident that the influence of subsistence patterns on the general form of socio-economic organization is great among the hunting and gathering peoples in areas of low productivity. Among the Carrier, at least, the framework of a given economy permitted several very unlike kinds of society, the choice between them depending on the influence of ideas from other peoples rather than upon economic necessity. Anthropology will not, however, be in a position to formulate any important generalizations about determinism in social change until this problem has been analyzed in many societies of different kinds. Each analysis must clarify the complex interaction of economic technology, environment, socio-economic organization and diffusion of ideas.



RUGGED SOUTHERN ALPS. FOX GLACIER, SOUTH ISLAND

IN SCENIC BEAUTY AS WELL AS STRUCTURE THESE ALPS RESEMBLE THE ALPS OF SWITZERLAND. ACTIVE GLACIERS DESCEND THE MOUNTAIN VALLEYS ALMOST TO SEA LEVEL.

SOME PROBLEMS IN NEW ZEALAND'S POLITICAL GEOGRAPHY

By Dr. ADELBERT K. BOTTS

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The stronger the vicinal location, the more dependent is the people upon the neighboring states, but the more potent the influence which it can, under certain circumstances, exert upon them. . . . The stronger the natural location, on the other hand, the more independent is the people and the more strongly marked is the national character.

—*Semple.*

STRONG natural location dominates the political life of New Zealand. Thousands of miles of water isolate her from the centers of world activity, and twelve hundred miles of water form an effective barrier between her and her nearest continental neighbor, Australia. Independence characterizes the political and social life but not the economic activities of the smallest dominion.

It is common for New Zealanders to consider their independence practically as complete as that of the United States. It is, so far as their political activity and social and governmental matters are concerned. On the other hand, strong sentimental ties and economic dependence upon Great Britain contrast sharply with, and in many respects counteract the natural tendencies toward, independence.

To outside observers living among the New Zealanders for several months before the present conflict in Europe broke it was readily evident that New Zealand was eminently loyal to Britain. There were signs on every hand that as soon as England moved toward war the small dominion would be closely in her wake. In fact, one could not help feeling that on frequent occasions, the "colonials" were distinctly impatient with the tolerance shown toward the dictators by officials "at home."

By October, 1940, New Zealanders were deeply involved. Besides building a large home reserve, sending many men to the Near East, providing huge quantities of butter, wool and cheese for the mother country, these people further expressed their loyalty by enacting a new and drastic loan law and excess profits tax. By its enactment 15,000 individuals and 3,000 corporations will pay the government £8,000,000 ($25,920,000.00) as a war loan without interest for three years.

NATURAL LOCATION OF NEW ZEALAND

NEW ZEALAND (A), ONE THOUSAND MILES FROM NORTH TO SOUTH, IS SEPARATED FROM ITS NEAREST GREAT NEIGHBOR, AUSTRALIA (C), BY THE TASMAN SEA (B), 1,200 MILES WIDE. THE HAWAIIAN ISLANDS (D), WHERE MUCH OF OUR PACIFIC FLEET IS STATIONED, LIES 3,800 MILES NORTHEAST OF AUCKLAND. A SECONDARY AMERICAN SEA BASE IS LOCATED AT PAGO PAGO IN THE SAMOAN ISLANDS (H). THESE TWO POINTS TOGETHER WITH SINGAPORE (G) FORM THE STRATEGIC DEFENSE "LINE" BETWEEN THE TWO SOUTH PACIFIC DOMINIONS AND JAPAN (F). PANAMA CANAL (E) IS IMPORTANT AS AN ALTERNATIVE GATEWAY FROM THE SOUTH PACIFIC TO ENGLAND.

The new tax rate will be 60 per cent. of profits remaining after deduction of the existing income, social security and national security taxes.

The problems of participation in the present world struggle in Europe do not completely obscure the concern of these people for the international problems of the Pacific area. New Zealand fears Japan—not with a tangible fear but with a subconscious realization of her own weakness and of the prizes she might possess for a conquering Japan.

During a brief visit in Dunedin in May, 1939, the writer spent an evening with an educator of that community. Early in the evening the host had to leave to attend a meeting of school officials. Their task that evening was to work out details for the evacuation of Dunedin's school children in case of an air raid. To an American the idea seemed fantastic.

FRANZ JOSEF GLACIER

AS IT IS SEEN FROM OUTLOOK POINT. THE MOUNTAINOUS AND FIORDED SOUTHWEST COASTAL REGION IS PRACTICALLY UNINHABITED, BUT PEOPLE TRAVEL THOUSANDS OF MILES JUST TO EXPERIENCE THE GRANDEUR OF ITS SCENIC BEAUTY.

Dunedin is at the southern end of one of the most isolated countries in the world, but is taking serious steps to prevent an air raid disaster. And she is not alone in her anxiety. Each of the other New Zealand cities is taking similar precautions.

There are several good reasons for their concern. Japan is not so far from New Zealand as most of us assume, especially when we think in terms of island stepping stones. For almost half a century Japan has been expanding farther and farther south. Where she has been unable to conquer territory, as in Formosa and China, she has used more subtle means, some of them peaceful. After the last war she received mandates over the former German island groups, Mariana, Caroline and Marshall, territorial island bases in the west central Pacific. For years the Japanese have been moving into the Philippines. Although the Japanese are not numerically dominant, their attitudes and organization make them a group to be reckoned with. New Zealand looks upon the Philippine situation as a possible threat to herself if the present plans for Philippine independence materialize. With realism characteristic of their European associates the New Zealanders expect Japan to move into the Philippines when the Americans move out. Nothing is much more potent as a cause for jitters than the realization that Japan is moving closer and closer to New Zealand.

Observing a world map, we are likely to assume that New Zealand has little to offer Japan as an object of conquest. Certainly her bulk does not impress one who has a continental viewpoint. But Japan's viewpoint is not continental. She is an island country herself and can appreciate the resources and advantages of New Zealand.

The latter is about two thirds as large as Japan, but much richer in agricultural resources. The amount of cultiv-

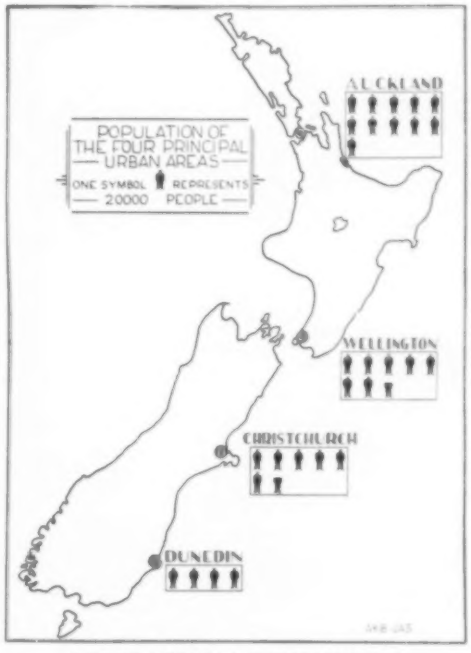
able land in New Zealand is greater than that in Japan. Japan with about twenty-two thousand square miles of cultivable land supports almost seventy million human beings. New Zealand, on the other hand, with nearly twenty-nine thousand square miles of cultivable land supports only one and one-half million inhabitants. Underpopulation in New Zealand is almost as serious a problem as is overpopulation in Japan.

New Zealand lies between thirty degrees and forty-eight degrees south latitude. Japan lies between thirty degrees and forty-five degrees north latitude. Climatically they are similar, although Japan experiences greater temperature extremes because it lies in the immediate lee of a tremendous continent, while New Zealand is separated from its nearest continental neighbor by the broad Tasman Sea.

From the point of view of political geography, New Zealand is not an easy land to defend. The sparse population is scattered over the coastal lowland throughout the entire thousand miles of north and south extent with major concentrations at four widely separated points.

The largest urban area, Auckland and its suburban communities, with about one seventh of the total population of New Zealand, occupies a narrow isthmus in the northern part of the North Island. The island there is less than six miles wide. On the east it faces the Pacific and on the west, the Tasman Sea. It may be approached from either side; but only the eastern side can accommodate oceanic traffic. The task of providing defense for that crowded isthmus is a major military problem.

About four hundred miles south of Auckland, at the southern end of the North Island is the capital, Wellington, a city of 125,000. It has somewhat better natural protection than Auckland, but is vulnerable because of the concentration of its industrial developments.



POPULATION DISTRIBUTION

THE FOUR PRINCIPAL URBAN AREAS OF NEW ZEALAND ARE ALL COASTAL COMMUNITIES AND CONTAIN 580,000 PEOPLE, APPROXIMATELY ONE THIRD OF THE TOTAL DOMINION POPULATION. THE PROGRESSIVE DECREASE IN SIZE FROM NORTH TO SOUTH REFLECTS LARGELY THE INFLUENCE OF ACCESSIBILITY TO WORLD TRADE ROUTES.

The South Island has two important population concentrations also, one at Christchurch and the other at Dunedin. In addition, there are smaller concentrations forming an intermittent line of population on all the coasts except on the southwest part of the South Island. In no case are there significant population concentrations at any points more than twenty-five or thirty miles from the sea.

With such a long thin line of population the cost of adequate defense against aggressive attack is prohibitive to a population of one and one-half million. That is not to imply that New Zealand is not spending for its own defense. She is, and highly too. But the task is a huge one.

Doubtless real aggressive warfare in that part of the Pacific would do much

AIR PHOTOGRAPH OF AUCKLAND HARBORS

AUCKLAND OCCUPIES A NARROW ISTHMUS BETWEEN THE TASMAN SEA AND THE PACIFIC OCEAN. ONLY THE WAITEMATA HARBOR ON THE PACIFIC SIDE IS OF ANY VALUE FOR OCEAN SHIPPING. THE ENTRANCE TO MANUKAU HARBOR IS TOO SHALLOW FOR SAFE USE.

to unite the two dominions of Australia and New Zealand into a much closer union than either is willing to advocate at the present time. Also both countries are likely to favor closer ties with the United States. Favorable trade concessions with the United States are quite likely if the South Pacific countries can be made to feel that we are sincerely interested in their security. The recent appointment of our first minister to Australia seems to indicate the truth of that assumption. It is much better for those countries to sacrifice some of the independence nature has given them in order to secure the protection of a country of their choice than it is to lay themselves open to the conquest of uncongenial "foreigners."

Dependence on the strong arm of Britain was not a matter of blind faith. New Zealand and Australia got much consolation out of the base at Singapore and they gladly gave aid to the mother country in exchange for the help they hoped to receive from "Home" if the occasion arose.

Thoughtful New Zealanders recognize the principal flaw in that arrangement. It is evident that if England weakens, or if Pacific troubles intensify while the home land is busily engaged in Europe, the help they have bargained for can not be delivered. The only solace in that case is the United States.

It is remarkable the amount of satisfaction New Zealanders get out of our Pacific Fleet. They look upon it—if not as their first line of defense—certainly as a major bulwark against Japanese aggression upon English-speaking lands of the Pacific. All through New Zealand and among all classes of people one hears most positive evidence of such an attitude. They apparently have absolute confidence that the United States would

not stand idly by and let them be gobbled up by any Eastern Power. At least that was their belief before September, 1939.

The problem of the density of New Zealand's population (about 16 per square mile) is fully as important as its problem of population distribution. A million and a half people occupying a land which could support ten million in comfort is a serious geographic and political matter. Protecting the space against the designs of "people without room" assumes considerable proportions. There is constantly the feeling that, if the owners do not use the country more economically from an international point of view, some one else will. Population increase becomes, at least academically, a popular and much discussed topic. Obviously, the intelligent thing is for New Zealand to increase her population and use her space adequately. The only difficulty is that she can not do it. There are several reasons why New Zealand can not readily relieve the dangers of underpopulation.

The two most popular formulas for improving the situations are: first, increasing the relative birth rate, and, second, immigration. Observed fact tells us that the first can be no solution in this case. In spite of a governmental campaign to increase the birth rate, statistics for 1936 and for 1937 indicate that the net reproductive rate is not sufficient to maintain the population at its present figure. The birth rate is rising slightly but not sufficiently to encourage any one to believe that New Zealand can ever achieve optimum population density through her own reproduction.

Our own country achieved its present density (41 per square mile) mostly by means of immigration. It is a thoroughly effective way to populate a country but carries with it a number of

AUCKLAND'S MAIN BUSINESS DISTRICT ON WAITEMATA HARBOR

THE LOWER LEFT FOREGROUND SHOWS TWO OF THE PRINCIPAL OVER-SEAS DOCKS; THE LOWER RIGHT FOREGROUND SHOWS THE FERRY DOCKS. AT THE CENTER OF THE PICTURE IS QUEEN STREET, THE COMMERCIAL CENTER OF THE CITY.

Courtesy Dorothy Lewis

MOUNT EGMONT, AN EXTINCT VOLCANO IN PRODUCTIVE DAIRY REGIONS

ALMOST ALL THE LOWLAND AREA IS DEVOTED TO GRASSLAND AGRICULTURE. TARANAKI REGION, IN WHICH THIS MOUNTAIN IS LOCATED, LIES ON THE HUMID SOUTHWEST COAST OF THE NORTH ISLAND. GOOD WINTER AND SUMMER ARE EXCEEDINGLY RARE.

handicaps. We have practically discontinued the process and so has New Zealand, and for approximately the same reasons. In the present social order it is quite impossible for nationals to meet the economic competition of the immigrant and at the same time maintain the standard of living to which they have become accustomed—or to which they hope to become accustomed. Socialized legislation is a definite deterrent to immigration.

Usually, in the middle latitudes, those people with meager economic and social resources or opportunities migrate most readily and in greatest numbers. They bring to the new country only their skill and man power. In a new and undeveloped country that is sufficient. But New Zealand is no longer a new and undeveloped country. She has reached a high stage in her present type of economic and social organization. She maintains a high standard of living and will not permit any class to be oppressed. But she wants to retain the benefits of that organization for those who have worked to achieve it. Immigrants simply do not fit into the scheme of things unless they have sufficient wealth to maintain a standard of living equal to that of the average New Zealand working man. The chances are, if a migrant has that much wealth in his home land he will be quite happy to stay there and enjoy it.

There are very few opportunities in New Zealand for specialists or for people with highly developed skills. Such people are social and economic luxuries beyond the financial reach of a country with limited population and modest means. The fact prevents specialists from other countries from moving to New Zealand. Much worse, it costs New Zealand the loss by emigration of many of her most promising sons. It has long been a cause for annoyance among New Zealanders that her Rhodes Scholars and other highly trained young men have chosen the United Kingdom rather than their home land as a permanent residence after their period of training is past. Great Britain shows great eagerness in acquiring intelligent young scholars from the dominion. New Zealand appreciates the tribute, but considers it small compensation for her loss.

There are certainly many oppressed people who would welcome a chance to try their luck in a land of opportunity. Why should not an underpopulated land such as New Zealand allow them to take that chance? There are three reasons: In the first place, many of these people without opportunities at home belong to races quite different from the race of the governing people in the new country. No country now is willing to assume the difficulties of a racial minority group if that can be avoided.

Against immigrants of the same race or even of the same original nationality there are the other two objections:

The most effective way for immigrants to establish themselves is to sell their labor or the products of their labor at a lower price than others will accept. While they do that they must live on a low standard. In order to meet the competition, established labor must cut wages and lower standards. That obviously is not a likely course for New Zealand's labor union controlled government to foster.

The only other way in which the country can be made attractive to immigrants is to subsidize the immigrant sufficiently so that he can maintain an acceptable standard of living for the country and, at the same time, compete with established labor on its own level. To carry this out on any large scale would increase materially the tax burden with which the country is already oppressed. Regardless of values it is not a likely solu-

tion to the problem. Under any circumstances the benefits would be too distant and the expense too immediate for any transitory political organization to face even if it were inclined to attempt the task.

Several years ago an attempt at the application of a scheme of the last mentioned type was attempted. A system of assisted immigration was put into effect but has practically ceased to operate. The general scheme of governmental assistance to immigrants is based on nomination by a person already dwelling in New Zealand, who undertakes to find employment for his nominee. He must guarantee that his nominee will reside at least five years in New Zealand. Since 1925 not more than seven thousand immigrants have been assisted in that manner and during the years 1933–37 inclusive the greatest number assisted in any one year was eleven.

Homogeneity is characteristic of the present population of New Zealand. Approximately 95 per cent. of the total population is of British descent. Slight provincial differences have resulted from the dissimilar geographic environments of the widely separated larger communities. But common descent with its many traditions, a strong central government and common economic and international problems bind the parts closely together. The only significant minority population group is the Maori native. Even they are so much involved in the general New Zealand culture and are gaining so much from their contacts with the British that it is certainly incorrect to think of the Maoris as constituting a minority problem in the sense that those words imply to-day.

New Zealanders are generally proud of their treatment of the Maori. During the hundred years of close contact, in exchange for the land which he formerly owned, the British have transformed the

POI DANCERS IN ROTORUA DRESSED IN NATIVE COSTUME

ON CEREMONIAL OCCASIONS AND FOR THE BENEFIT OF TOURISTS, THE MAORIS STILL DRESS THIS WAY AND DANCE THEIR NATIVE DANCES. AT OTHER TIMES THEY LIVE VERY NORMAL LIVES AS ORDINARY PARTICIPATING CITIZENS OF THE DOMINION.

MAHI POKI

MAHI POKI WAS ONE OF THE CHIEFS WHO EXPERIENCED THE FIRST IMPACT OF EUROPEAN CIVILIZATION UPON THE POLYNESIAN STONE AGE CIVILIZATION OF HIS ANCESTORS. HE AND HIS COLLEAGUES FOUGHT FOR THE PRESERVATION OF THE GOOD LIFE AS THEY HAD KNOWN IT BEFORE THE OUTSIDE WORLD THRUST ITSELF UPON THEM.

MATTIU TE HAU

THE MAORI OF THE PRESENT DAY HAS ADOPTED MANY CUSTOMS OF EUROPEAN CIVILIZATION, BUT THEIR LOVE FOR THEIR NATIVE LAND IS JUST AS STRONG AS THAT OF THEIR ANCESTORS. IN BOTH WORLD WARS MANY MAORI LADS HAVE MARCHED SHOULDER TO SHOULDER WITH THEIR "PAKEHA" BROTHERS IN DEFENSE OF CIVILIZATION.

Maoris from exceedingly war-like, stone age cannibals into peaceful, industrious citizens. It is generally agreed that the Maori fared better at the hands of the New Zealander than the Indian did at the hands of the American. It is also evident that the Maori enjoys much greater economic and social equality with his pakeha (European) neighbors than is the case with our American Negro.

However, it is not quite fair to attribute this better treatment to a higher sence of social justice on the part of the British. Such is hardly the case, and many New Zealanders recognize the fact. The Maori has never been an economic threat to the Europeans. His numbers, about 5 per cent. of the total population, are not great enough to cause any serious economic conflicts. The Maori reproductive rate is higher than that of the British New Zealanders; but in an underpopulated country that is not likely to cause any difficulties for many years, if ever.

Credit must certainly be given to both these ethnic groups for the admirable way in which they have taken advantage of their opportunities to live together peaceably and fairly. There is surprisingly little race prejudice. Intermarriage is not uncommon and carries with it none of the social ostracism usual in our country. In proportion to the size of the group the natives and mixed population have produced their full share of New Zealand's notables. Among them are Sir Aparana Ngata, a member of parliament, at one time a member of the Cabinet, and reputedly the greatest liv-

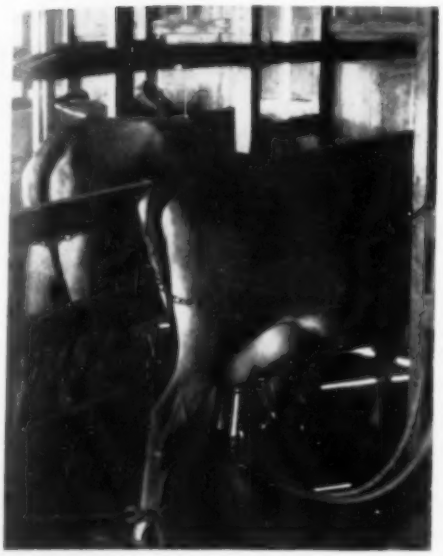
ing orator in the country; "Princess" Te Puia, a Jane Addams to the Waikato Maoris; Dr. Peter Buck, the director of Bishop Museum in Honolulu and a leading anthropologist on the staff at Yale University; and Dr. L. H. Potaka, member of Byrd's second Antaretic Expedition. A social order which permits and encourages the development of such talent is indeed commendable. The Maoris have so far adopted the European culture of their British neighbors that they think about world affairs in a characteristically European manner. In the last war the Maoris carried their full share of the burden. In the present conflict they are again joining the military forces for the protection of their common country. Plans are now under way for the formation of an all-Maori battalion of the men now enrolled and those who are ready to enlist.

Economically, New Zealand is far from achieving the independence Semple ascribes to isolated countries. Her resources are principally agricultural. She possesses sufficient good quality coal for her own needs but is practically devoid of economically valuable iron, the other basis of modern industrial development. No petroleum deposits of significance have been discovered; but her water power resources are abundant and well developed. Forests were once plentiful and still are in many localities. Some reforestation has been accomplished but not in sufficient amounts to compensate for the ruthless deforestation practices of the last half century.

Some degree of self-sufficiency in manufacturing is maintained by virtue of an exorbitant import tariff. Persons engaged in manufacturing industries constitute approximately 6 per cent. of the

ARAPUNI POWER STATION ON THE WAIKATO RIVER

NEW ZEALAND HAS AN ABUNDANCE OF POWER FOR HER INDUSTRIES FROM COAL AND WATER. HERE THE WAIKATO RIVER WAS DIVERTED FROM ITS FORMER COURSE BY VOLCANIC ACTIVITY. THE POWER FROM THIS STATION CONTRIBUTES LARGELY TO THE NEEDS OF ONE OF THE MAJOR DAIRY REGIONS OF THE NORTH ISLAND. IN NEW ZEALAND THE USE OF ELECTRICITY IS ALMOST UNIVERSAL.



MODERN MILKING SHED IN TARANAKI
BARNS ARE UNNECESSARY IN NEW ZEALAND BECAUSE OF THE MILD WEATHER, AND MILKING IS GENERALLY CARRIED OUT IN OPEN SHEDS, DESIGNED TO ACCOMMODATE SIX OR EIGHT COWS.

total population. That is considerably higher than the figure for agricultural states in the United States, but less than the figure for manufacturing states. In Iowa 2 per cent. of the population is engaged in industry. In Minnesota the figure is 3 per cent. Pennsylvania and Ohio each employs 8 per cent. of its population in industry and Massachusetts, 10 per cent.

Of the ninety-six thousand New Zealanders employed in manufacturing, more than three fourths manufacture for home consumption. Fewer than one fourth are engaged in industries manufacturing for export. Almost all those engaged in manufacturing for export are engaged in processing agricultural products: wool, milk, cream, meat and hides. The country is second only to Denmark as an exporter of butter, and is the world's greatest exporter of cheese. She is the biggest supplier of both commodities to the United Kingdom. Hers is the greatest trade per head of population of any country. She is dependent upon outsiders for: motor vehicles, machinery, metal manufactures and textiles, which together constituted 51 per cent. of the value of imports in 1937.

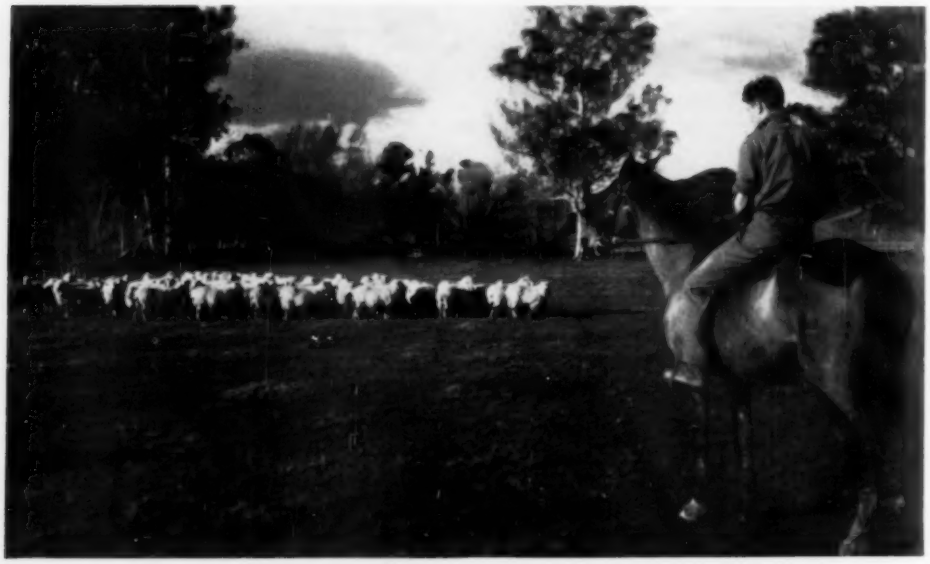
Of the political, geographic and economic problems facing New Zealand today, none have had more space in the press of the country than the problems of overseas trade.

Financially, the government has, for a good many years, been living on the instalment plan. The government railways, power developments and other beneficial and necessary improvements have been financed by foreign borrowing. Consequently, the country is laboring under a very burdensome foreign debt, one that makes itself felt in every town and village, in every home and in every industry. Payment of interest on that foreign debt uses the value of a large part of the exports every year. Ob-

MANUFACTURING BUTTER, TARANAKI
BUTTER FACTORIES ACCOUNT FOR A VERY LARGE SHARE OF THE MANUFACTURING IN NEW ZEALAND. IN THE YEAR 1936–37 THEY PRODUCED ONE FOURTH OF ALL FACTORY PRODUCTION.

GRAIN HARVEST SHOWN IN THE NORTHERN CANTERBURY PLAINS

GRAIN PRODUCTION IS A MINOR PHASE OF AGRICULTURE IN NEW ZEALAND. THE COUNTRY IS SELF-SUFFICIENT IN ITS GRAIN REQUIREMENTS, ONLY BECAUSE OF STRICT IMPORT REGULATIONS.



SHEPHERD WITH A SMALL "MOB" OF SHEEP NORTH OF NAPIER

SHEEP DOMINATE DRIER EASTERN AREAS. WOOL AND MUTTON ARE EXPORTED AND THE FORMER IS ONE OF THE CHIEF EXPORTS OF THE COUNTRY. DURING MOST YEARS THE VALUE OF WOOL EXPORTED APPROXIMATES THE VALUE OF BUTTER EXPORTED.

viously, the more export value used to pay interest and to reduce the principal of the debt, the less value there will be available to pay for import goods.

In a recent broadcast, Mr. Walter Nash, the Minister of Customs, made the following explanation to his people:

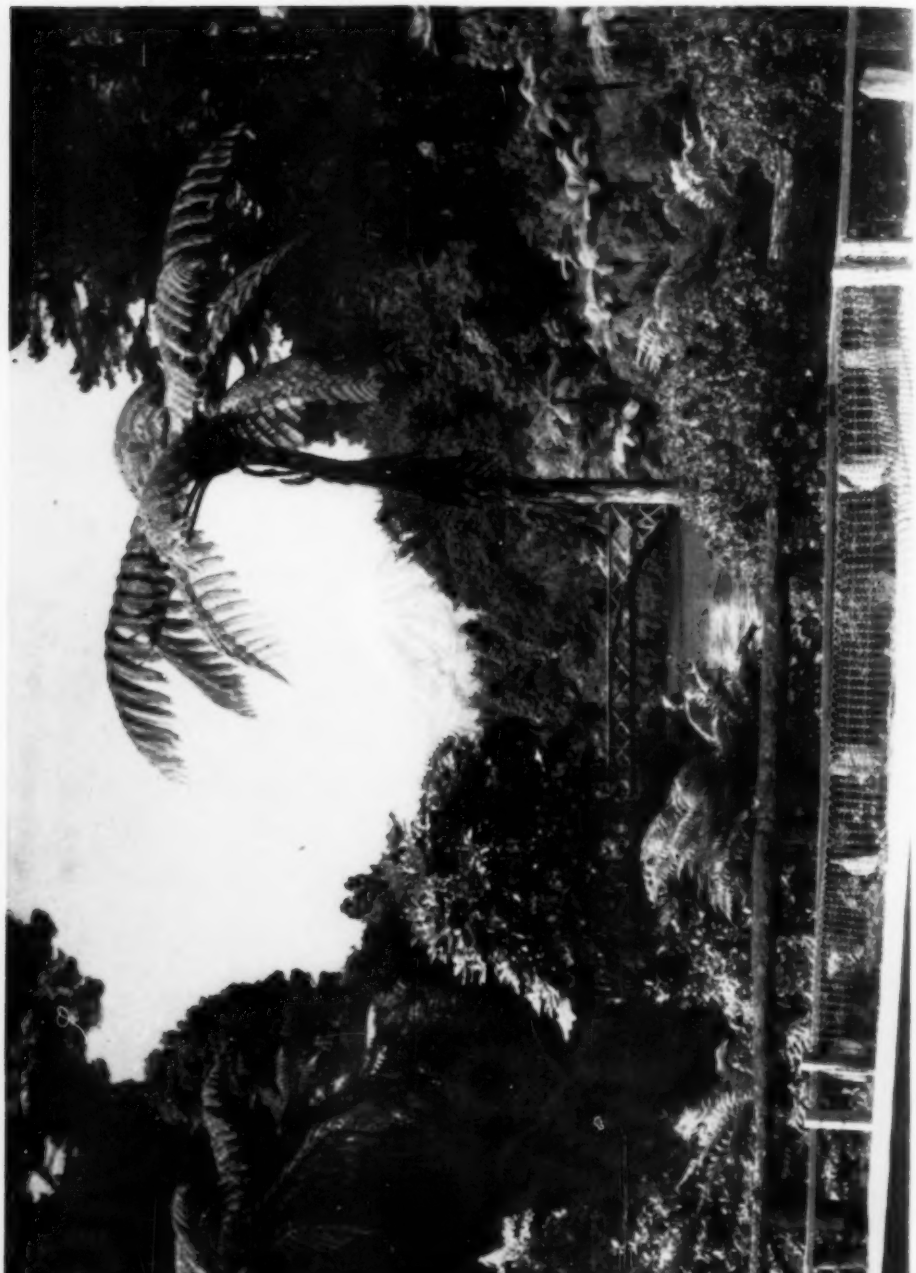
Granted that New Zealand was short of sterling funds, the question was: What was the best way of meeting this position in the interests of New Zealand? We had a certain amount on interest to pay on our debts, a certain amount of capital to be repaid from Government and local body debts. These had to be paid—there was never any question that they would not be. There was a certain amount left over for imports. That means that no matter what system had been devised, it would have been impossible to pay for any more imports than had been paid for this year (1939).

But in the main people in New Zealand were in employment: they were getting more reasonable wages: their spending power was increased. They still wanted the same amount of goods, the same purchases in the shops, and so the shops demanded of wholesalers and manufacturers the same amount of goods. This meant that manufacturers and importers were demanding the same amount of raw material and finished goods. Yet we were in a position where we had not sufficient overseas money to pay for the goods which this demand would need. The advice given by some sections of the community was that the Government should cut down public works, cut expenditures, retrench on social services and generally repeat the procedure adopted in past years. This means that these people were advising that thousands of men should be put out of work, that their families should suffer, that those who need social security should do with less, and that generally the poorer paid section of the community should bear the burden of what is a national problem, namely, the cutting down of imports. The Government refused emphatically to adopt this course. Accordingly it worked out a system of keeping imports within our capacity to pay for them, but which was not based on cutting wages or retrenching on public works. This procedure has been called the import selection policy.

The government decided that if imports were to be cut, then it would choose which ones were to come into New Zealand: it would choose the more essential ones instead of cutting everything by some fraction, whether it was an important or an unimportant commodity. The Government decided that some things would be allowed in unrestricted, while other things not so important would be cut down some more.

WHEAT PRODUCTION ON FERTILE SUB-HUMID CANTERBURY PLAINS

THIS SMALL AREA PRODUCES ALMOST ALL THE GRAINS FOR THE WHOLE OF THE DOMINION AND IS ABOUT THE ONLY PLACE IN NEW ZEALAND WHERE ANNUAL TILLAGE OF THE SOIL IS COMMON.



CHARACTERISTIC SUB-TROPICAL VEGETATION IN PUKEKURA PARK

Courtesy Frances Ritchie

During the five-year period 1933–1937 merchandise and specie exports accounted for 92 per cent. to 94 per cent. of the country's overseas credits. On the other hand, imports accounted, during the same years, for less than 70 per cent. of the overseas debits. In each of those years payments on interest and principal, mostly interest, required more than 21 per cent. of the value of the total foreign credits. In other words, more than one fifth of the exports were used to pay interest on the cost of goods which had been imported long ago.

Disregarding the fact that much of the indebtedness was incurred in establishing vital capital goods in the country, the fact remains that New Zealand is a debtor nation with rather extravagant tastes in matters of import goods. New Zealanders travel extensively. They know quality goods, and have been subjected to pressure salesmanship from nations wishing to provide New Zealand's imports. Increased local prosperity since 1935 after a period of depression caused even greater demand for import goods—quite in excess of the value of exports after the necessary interest payments had deen deducted. The situation became so serious that the government found it necessary to institute direct import and export control in December, 1938.

The import restrictions particularly have had a tremendous effect upon the everyday lives of all the citizens. American cereals, canned goods, coffee, cigarettes, tobacco and many articles of clothing were wiped off the import list completely. Washing machines, electric refrigerators, cameras (just to mention a few luxury and semi-luxury goods) are permitted only when one can prove an absolute need. It is not possible to import anything without an import license. Furthermore, one must secure the authority of the Bank of New Zealand before any money or credits can be sent out of the country in payment for import goods or for any other purpose. Possession of an import license does not imply the right to use New Zealand credits in payment for imports. Importing goods and paying for them are two separate and distinct matters and each must have the specific authorization of a different governmental department before it becomes valid and legal.

In addition, export control requires that the overseas credits arising from the sale of goods must be sold to a New Zealand bank in exchange for New Zealand currency. Thus the government acquires control of all new overseas credits whether of public or private origin.

Aside from the effects of this kind of control upon the people of the country, there is another effect of greater significance in the realm of international politics. The government has in its hands a device by means of which it can efficiently but unobtrusively guide the directions of overseas traffic flow. That those who hold this device know of its value and apply it is evidenced by another excerpt from Mr. Nash's radio speech quoted above:

> We are purchasing from England as much as we have money to pay for, and we are buying a bigger proportion of our needs in England under this import selection policy. This year the government is spending much more money on defence equipment and some millions of pounds had to be set aside to buy these goods. This means that we can purchase less of other goods. Summed up, the import selection policy enables New Zealand to keep its people in employment, it enables us to build secondary industries rationally, it enables us to give more trade to England, and it enables us to make ample provision for the payment of interest on our debt.

Since London holds most of New Zealand's notes, it is natural that the debtor should try to direct as much of her trade in that direction as possible. The fact

CHARACTERISTIC SUB-TROPICAL VEGETATION IN PUKEKURA PARK *Courtesy Frances Ritchie*

that Britain is the greatest market for New Zealand goods adds another excellent reason for that practice. Tariffs have always favored the United Kingdom over other competitors for the New Zealand market; but in many items the United States, Canada and others have been able to create a worthwhile business in spite of heavy duties. Application of the new device, import and export licensing, has practically eliminated Britain's competitors from the field.

The effects of these restrictions upon the country internally are hard to forecast. It can hardly be denied that an attempt to live within her world trade income and to pay her debts are commendable ambitions. The necessarily rapid readjustments of commerce and industry within the country may cause some severe temporary difficulties. But the natural resources are fair and the cultural resources are superior. A century of experience in isolation has educated the people in the need for initiative and for sacrifice in the face of difficulties. In spite of present economic dependence on her mother country, New Zealand revels in the privileges of independent national character born of her natural location.

CONTRIBUTION OF SCIENTISTS TO NATIONAL DEFENSE

THE first way in which the institute (Massachusetts Institute of Technology) responded to the national emergency was to release experts from its staff to serve in various operating or advisory agencies of the government. Nearly two hundred officers and members of our staff are now engaged in this type of service. Those in this group whose salaries continue to be paid by the institute contributed during the past year approximately fifty thousand man-hours of time to defense, and the others have been temporarily transferred to governmental pay rolls, usually requiring new substitute staff appointments to carry the teaching loads which they have temporarily relinquished.

As the nation's gigantic defense program got under way it quickly became evident that the supply of men with an engineering type of training was very inadequate. Consequently, last October Congress appropriated $9,000,000 to finance an engineering defense training program to be conducted in qualified colleges under the auspices of the United States Office of Education. The institute has participated in this program by offering during the second term of last year and this past summer twenty-seven intensive tuition-free courses of college or post-graduate grade, with an enrolment of 929 students. . . .

The instruction in this program was given by ninety-four instructors, of whom eighty-one were from the regular staff of the institute. These instructors carried this program as an addition to their normal institute work. The funds, provided by the Office of Education, totaled approximately $128,000, which covered salaries, instructional material and supplies, maintenance and repair of equipment used in the courses and the purchase or rental of equipment. The basic financial policy of this engineering defense training program of the United States Office of Education is to reimburse the cooperating colleges for all direct out-of-pocket expenses, but with no allowance for overhead. . . .

Apart from this special defense training program under the Office of Education, we are engaged in a variety of other types of defense training. The Navy continues to send us a group of Naval officers for graduate study, and of the sixty officers who were detailed here last year, forty studied naval construction and naval engineering and the remainder took special work in meteorology, electrical engineering, mechanical engineering or aeronautical engineering.

Last summer a special intensive course in meteorology was given to recruits for the Army Air Corps, and during the past academic year another group of approximately sixty post-graduate students came for training for the Army Air Corps and the United States Weather Bureau. This course is now being repeated for a considerably enlarged group.—*Report of the President, Massachusetts Institute of Technology.*

STRUCTURE OF THE COTTON FIBER AS REVEALED BY THE MICROSCOPE

By Drs. CHARLES W. HOCK and ROBERT C. RAMSAY

RESEARCH ASSOCIATES OF THE TEXTILE FOUNDATION, NATIONAL BUREAU OF STANDARDS

COTTON fibers originate as single-celled outgrowths of epidermal cells of the seed coat. The first evidence of their formation is the appearance on the day of flowering of a swelling on the outer wall of the epidermal cells. The tubular outgrowths thus formed elongate rapidly for a period of 15 to 20 days, when growth in length ceases. During this stage of growth only a thin *primary wall* encloses the protoplasm of the cotton hair. Thereafter the thickness of the wall is increased by a deposition of cellulose which comprises the *secondary wall*. The latter is laid down on the inside of the primary wall, thereby decreasing the size of the central cavity which contains the living protoplasm. Secondary thickening continues until the boll opens, when the exposed hairs dry up and die. Thus, a mature cotton fiber is a single cell, usually more than a thousand times longer than it is wide, and attached to the seed only by its base. Although less than a thousandth of an inch in diameter, a fiber may attain a length of several inches.

In discussing the structure of the cell wall of the cotton fiber it is essential to differentiate between the primary and the secondary wall.[1] Since deposition of the latter does not start until from 15 to 20 days after the fibers originate, young fibers are ideal for studying the structure of the primary wall. When a young fiber is examined microscopically with ordinary light there is no evidence of structure in the thin primary wall. On examination with crossed nicols,[1] however, the fibers show a low order of birefringence, with colors indicative of a predominantly transverse orientation. After treatment with cellulose dyes the fibers give a faint color reaction, and upon examination with crossed nicols appear distinctly birefringent. This increase in birefringence upon staining is due, apparently, to the double refraction of the dye molecules which are preferentially adsorbed by the small amount of cellulose in the primary wall. When the stained primary wall is placed between crossed nicols so as to show its maximum brightness the cellulose is found to be present as crisscrossing strands which have a netlike appearance (Fig. 1). The reticulate structure of the cellulose in the primary wall appears to become coarser and to show greater birefringence as the wall increases in age.

Cellulose is not, however, the chief constituent of the primary wall. The

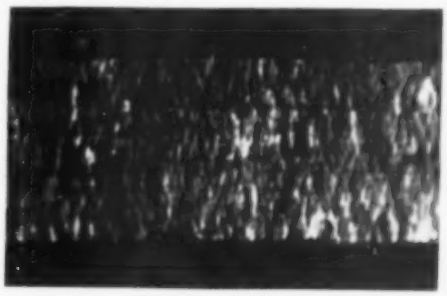


FIG. 1. FIFTEEN-DAY COTTON FIBER STAINED WITH CONGO RED AND PHOTOGRAPHED BETWEEN CROSSED NICOLS TO SHOW STRANDS OF CELLULOSE IN PRIMARY WALL. ×672.

[1] Substances which exhibit different indices of refraction along different axes are said to show double refraction or birefringence. One of the best ways for observing the optical properties of birefringent materials is to examine them with crossed nicols, which are prisms employed for polarizing light.

latter also contains wax and pectic materials which may be detected by applying various stains to the fiber, as well as by direct chemical analysis. When young fibers are purified by the removal of wax and pectin the delicate framework of cellulose always remains. It appears, therefore, that the primary wall is made up of a tenuous network of cellulose strands intimately associated with a membrane of wax and pectic substance. Although it comprises only a relatively small part of a mature cotton fiber, the primary wall greatly influences the surface properties of the fiber which play a prominent rôle in dyeing, finishing and other processing of cotton.

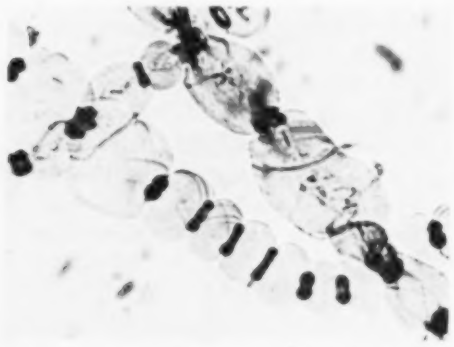


FIG. 2. MATURE COTTON FIBER IN CUPRAMMONIUM HYDROXIDE SOLUTION, SHOWING IRREGULAR SWELLING DUE TO CONSTRICTING INFLUENCE OF PRIMARY WALL. ×95.

The principal chemical constituent of cotton, and the one chiefly responsible for its usefulness to man, is cellulose. The bulk of the cellulose of a cotton fiber is in the secondary wall. Because it is a more favorable medium for study, and also because of its greater economic importance, the attention of most investigators has been directed mainly to this part of the fiber. As a result, much more is known about the structure and behavior of the secondary wall than is known about the primary wall.

Cuprammonium hydroxide solution is frequently employed, commercially as well as in the laboratory, as a solvent for cellulose. The reagent was first used nearly one hundred years ago by Schweizer, who made some interesting observations on the behavior of plant cell walls in this solution. When mature cotton fibers are placed in cuprammonium reagent they immediately begin to swell and twist. The rapid expansion of the cellulose of the secondary wall often results in the rupture of the primary wall. As the cellulose continues to push through such a break, expanded regions resembling beads appear along the axis of the fiber (Fig. 2). Where these expanded areas occur close together the fiber has an appearance resembling a string of pearls. After a short time, however, the cellulose dissolves completely, leaving a residue which consists principally of fragments of the primary wall, and to a lesser extent of material from the central cavity or lumen.

Full-strength cuprammonium reagent dissolves the cellulose of single cotton fibers or of cross sections in a relatively short time. Dilute solutions of the reagent, on the other hand, swell the fibers greatly but dissolution of the cellulose is retarded. Swelling fibers in this way offers an excellent means of observing details of their structure. When cross sections of cotton fibers are treated with dilute cuprammonium hydroxide solution the sections swell to many times their original diameter, thereby revealing a layered structure. On treating the swollen sections with a dye such as Congo red, alternating layers appear to stain deeply and lightly with the dye (Fig. 3, A and B). Between crossed nicols these sections show alternating layers of strong and weakly birefringent material (Fig. 3, C). The layered structure of the secondary wall can also be observed in longitudinal view (Fig. 4), where stripes running parallel to the fiber axis, and extending from the lumen to the primary wall, can be seen. The first

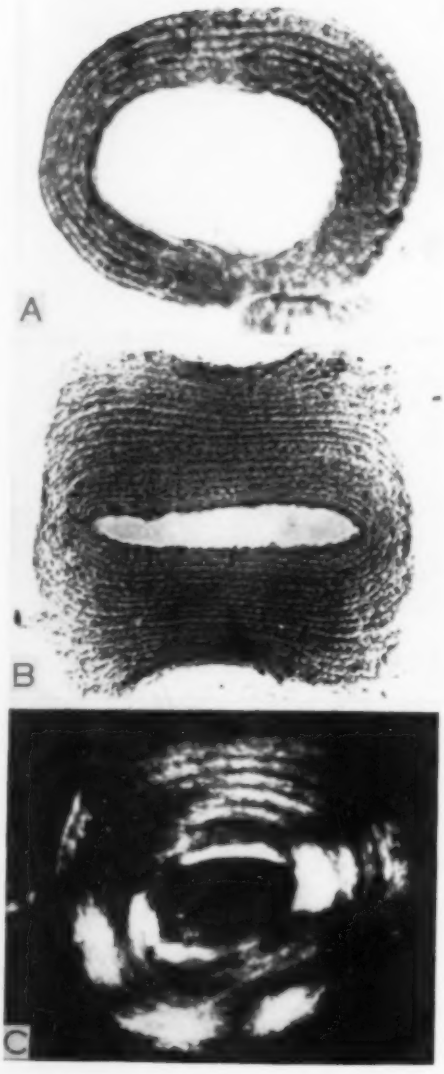


FIG. 3. CROSS SECTIONS OF FIBERS
COTTON FIBERS SWOLLEN IN CUPRAMMONIUM HYDROXIDE SOLUTION TO SHOW THE LAYERED STRUCTURE OF THE SECONDARY WALL. *A*. SECTION OF AN IMMATURE (25-DAY) FIBER. MAGNIFICATION ×811. *B*. SECTION OF A MATURE FIBER FROM AN OPEN BOLL. MAGNIFICATION ×363. *C*. SECTION OF A 26-DAY FIBER PHOTOGRAPHED BETWEEN CROSSED NICOLS. MAGNIFICATION ×600.

layer is laid down on the day when secondary thickening is initiated, the number increasing thereafter as the fiber approaches maturity. This increase in the number of layers with increase in age of the fiber can be seen by comparing Fig. 3, A with Fig. 3, B.

It has been shown that two adjacent layers, one compact and one porous, are deposited every twenty-four hours during the period of secondary wall deposition. Two adjacent layers together constitute, therefore, a daily "growth ring." The denser of the two layers which comprises each ring was found to be laid down during the day, the other at night. Counts of rings in fibers of different ages indicate that after the start of secondary growth, one ring is laid down per day until the fiber reaches maturity. The width of individual growth rings varies from one to five microns.[2] The width of

FIG. 4. LONGITUDINAL VIEW OF FIBER SHOWING THE LAYERS IN THE SECONDARY WALL OF A SWOLLEN 51-DAY FIBER. ×500.

[2] A micron is approximately one twenty-five thousandths of an inch.

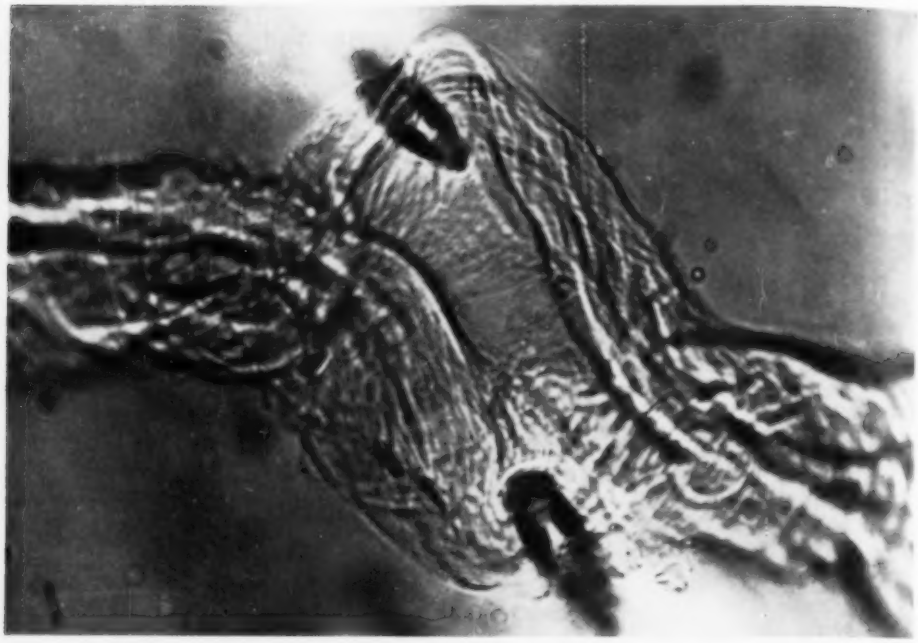


FIG. 6. A SINGLE SWOLLEN FIBER BEING DISSECTED WITH MICRO-NEEDLES TO SHOW ITS FIBRILLAR STRUCTURE. MAGNIFICATION ×625.

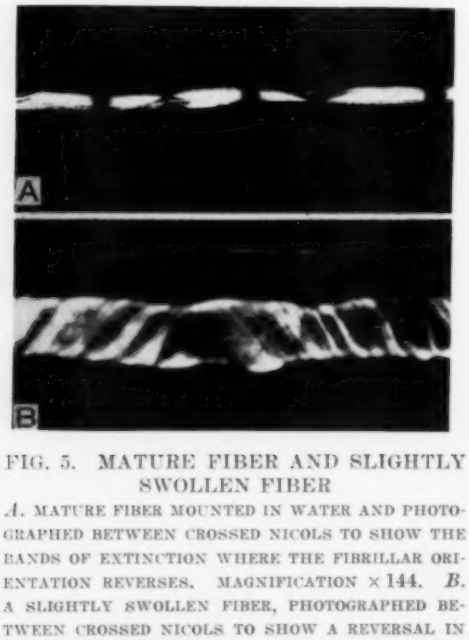


FIG. 5. MATURE FIBER AND SLIGHTLY SWOLLEN FIBER

A. MATURE FIBER MOUNTED IN WATER AND PHOTOGRAPHED BETWEEN CROSSED NICOLS TO SHOW THE BANDS OF EXTINCTION WHERE THE FIBRILLAR ORIENTATION REVERSES. MAGNIFICATION ×144. *B*. A SLIGHTLY SWOLLEN FIBER, PHOTOGRAPHED BETWEEN CROSSED NICOLS TO SHOW A REVERSAL IN THE DIRECTION OF ORIENTATION OF THE FIRST LAYER OF FIBRILS DEPOSITED IN THE SECONDARY WALL. MAGNIFICATION ×420.

the rings appears to fluctuate with variations in environmental conditions. For certain localities at least, variations in temperature and the width of the growth rings can be correlated. Thus, cotton fibers from different plants, but grown under the same conditions, show similar rings, so that it is possible to cross-date daily growth rings of cotton just as annual rings are cross-dated in the trunks of certain trees.

Upon examination of single cotton fibers with crossed nicols much can be learned about the orientation of the cellulose. When the fibers are placed approximately parallel to the plane of light passing through one of the nicol prisms, the high birefringence of the fibers is interrupted by dark extinction bands at irregular intervals along the axis (Fig. 5, A). These optical variations can be correlated with differences in structure observed in slightly swollen fibers. Upon swelling, the latter clearly reveal a fibrillar structure. The bulk of

the fiber is made up of innumerable fine fibrils oriented at an acute angle with respect to the axis of the fiber. The fibrils make either an "S" or "Z" twist,[3] reversal of direction (Fig. 5, B) taking place many times in a single fiber.

It appears also that, at least in certain types of cotton, the direction of orientation of the fibrils in the first-formed layer is opposite from that in layers which are laid down thereafter. In other words, if the first layer of fibrils makes an "S" twist, all the fibrils formed in subsequent layers make a "Z" twist.

It is readily apparent that reversals of direction of the cellulose fibrils are responsible for the optical differences observed with crossed nicols, and that the band of extinction is the place at which the reversals occur. It can be shown that the number of extinction bands in a single fiber invariably corresponds with the number of fibril reversals.

In carrying out microscopic investigations of this sort, the question often arises whether the structures which are seen are real. For example, are the apparent fibrils which may be observed under various conditions of illumination, real structures or are they due merely to surface irregularities or diffraction phenomena? To aid in answering such questions a micromanipulator can be of great help. This instrument makes possible the precise mechanical control of fine glass needles (about 0.0001 inch wide at the tip) whereby fibers can be dissected, flattened, stretched and otherwise handled so as to clarify details. When needles are inserted in the fine fibrils comprising the bulk of the cellulose of the secondary wall the fibrils may be separated from one another (Fig. 6) in a manner which makes it clear that the fibrils are real structures and not artifacts.

The system of fine threads or fibrils which make up the secondary wall are variously grouped so as to give a layered pattern. In an expanded transverse section of the wall the fibrils may be observed as more or less round structures. In the denser layers of the fiber there are, presumably, more fibrils per unit area than in the more porous layers which are deposited during the day.

Microscopic examinations thus make it clear that a cotton fiber, which at first glance may appear to be a relatively simple unit in itself, is in reality made up of still smaller structures upon which the properties of the whole fiber depend. The wall of a mature fiber appears to have the following structure. The secondary wall, which contains nearly all the cellulose of the fiber, consists of innumerable spirally oriented fibrils of exceedingly fine diameter. The secondary wall is enclosed by a thin primary wall which consists of a layer of wax and pectic material associated with a fine network of cellulose. The primary wall covers the secondary wall like a tight sausage casing and exerts a marked influence on the behavior of the fibers. The lumen or central cavity also contains wax and pectic substances, plus various amounts of degenerated protoplasm.

[3] The fibrils are said to show an S twist if, when the fiber is held in a vertical position, the spiral of the fibrils conforms in slope to the central portion of the letter "S" and a Z twist if the spirals conform to the central portion of the letter "Z."

ON THE SOTHIC CYCLE

By Professor WM. A. LUBY

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THE earliest astronomers known left no material evidence of their work. None of their ruined observatories nor their decayed instruments have resisted the course of time. Nor have their records of observations of the heavenly bodies been preserved. Singularly enough the proof of their activity was a calendar which they devised and induced a great country to adopt. That country was Egypt, and the calendar was the famous Egyptian calendar which remained in use for over forty centuries.

Extensive research by various Egyptologists has established numerous interesting facts concerning the Egyptian calendar. In that calendar the year consisted of twelve months of thirty days each and five holidays. This made a year of 365 days. Whether these early scientists knew that the year consisted of about 365¼ days or not is unknown. At any rate later Egyptian astronomers discovered that fact, but they did not change their calendar to take care of it.

It is indeed striking that the Egyptian calendar makes no attempt to use the lunar month of 29.5 days. The Babylonians, the Hebrews, the Greeks and the Romans endeavored in various ways to fit the lunar month into the year. One of these ways was to use months of 29 days and 30 days successively. This gave a year of 354 days. So extra months had to be inserted from time to time. The modern value of the lunar month 29.531 days and the tropical year 365.2422 shows the impossibility of an attempt to make one fit into the other.

The Egyptian year had three seasons called the Inundation, the Cultivation and the Harvest. The first season of the year shows by its name its relation to the annual rise of the Nile. At first, New Year's day was closely associated with one astronomical phenomenon, namely, the rising of the star Sirius just before the sun. This is the so-called heliacal rising of Sirius.

Egyptologists believe that the calendar agreed with the sun at the start. But in four years, the calendar would be in error by one day. In eight years, the error would be about two days. In 120 years the error would be approximately 30 days. As time passed the seasons would shift farther from their original place. Winter would come in the summer months and *vice versa*. Eventually the calendar would once more agree with the seasons and the annual rise of the Nile would again nearly agree with the first day of the year.

The Egyptian name of Sirius is Sothis. Hence the interval required for the seasons to shift through the year was called the Sothic cycle. According to the calculations of the time this was 1,460 years. This number is obtained by dividing 365 by one fourth.

Now the Egyptian calendar was used down to relatively modern times. According to Censorinus, a Latin writer, Sirius rose just before the sun in 139 A.D. This means that New Year's day in the civil calendar of Egypt once again agreed with the heliacal rising of Sirius. Counting back intervals of 1,460 years gives the dates 1318 B.C., 2781 B.C. and 4241 B.C. In his earlier work, Breasted gives 4241 B.C. as "the earliest recorded date in history." ("Ancient Times,"

page 45). Accordingly, the Egyptian calendar was put into effect on July 19, 4241 B.C.

In an article in the October number of THE SCIENTIFIC MONTHLY for 1935, Breasted gives the intervals 1318 B.C., 2776 B.C. and 4236 B.C. The reason for these slight differences need not concern us here. According to Dawson "the great majority of Egyptologists are in favor of the earlier of the last two dates, as the one on which the Egyptian calendar was inaugurated" ("The Age of the Gods," page 151). The Cambridge Ancient History is in substantial agreement with Breasted (Volume I, page 168). Meyer, in "Geschicte des Altertums" is in good agreement with both. He, however, uses 1,461 years, not 1,460, as the Sothic cycle (Volume I, page 109). This number is obtained by dividing 365¼ days by one fourth.

Whether the Egyptian calendar was inaugurated in about the year 2776 B.C. or in about 4236 B.C. is a matter for the Egyptologists to determine on the basis of the evidence. With that question the writer is not concerned. He does, however, wish to point out that the historians referred to have incautiously used an erroneous value for the length of the Sothic cycle. Hence each date determined by means of it is in error.

The matter is not determined by what the Egyptians thought the length of the Sothic cycle was. Newcomb, in his "Popular Astronomy," pages 47–48, writes: "After the lapse of 1,460 years, according to the calculations of the time, each season would have made a complete course through the twelve months, and would have then returned once more to the same time of year as in the beginning. This was termed the Sothic period; but the error of each year being estimated a little too great, as we now know, the true length of the period would have been about 1,500 years."

The length of the solar year is 365.2422 days. If we divide this by .2422, the result is approximately the length of the Sothic cycle or 1508.+ years. But the length of the year is changing. At the present time it is decreasing one second in 200 years. In the course of time it will increase again. The length of the day also appears to be variable. Hence after the lapse of many years the Sothic cycle itself changes slightly. Its length, however, is near 1,500 years, the value given by Newcomb.

Since a Sothic cycle of 1,460 years was applied three times previous to 139 A.D. the result given by Breasted is in error by at least three times the difference between 1,500 and 1,460 or 120 years. This gives $4236 + 120 = 4356$ B.C. This makes "the earliest recorded date in history" July 19, 4356 B.C. If the Sothic cycle, during the last 60 centuries, remained nearly constant at 1,508 years, the error would be about 144 years instead of 120. Apparently the Egyptian calendar was put into effect on July 19 in a year near or one somewhere within the interval from 4356 B.C. to 4380 B.C.

INVENTIONS AND WAR

By Dr. QUINCY WRIGHT

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THROUGHOUT the long history of war, there has been a cumulative development of military technology. Invention of defensive instruments has usually followed close on the heels of the invention of offensive weapons.[1] This balance of technology has tended to support a balance of power. But the balance has not tended toward increasing stability, consequently the political effect of military invention has not been continuous. There have been times when inventions have given the offensive an advantage and conquerors have been able to overcome the defenses of their neighbors and build huge empires. At other times the course of invention and the art of war have favored the defensive. Local areas have been able to resist oppression, to revolt and to defend themselves from conquest. Empires have crumbled, local liberties have been augmented and international anarchy has sometimes resulted.

During the last five centuries, military invention has proceeded more rapidly than ever before. Important differentials in the making and utilization of such inventions have developed. In general, the inventions have favored the offensive, and there has been a tendency for the size of political units to expand. This tendency was, however, arrested during much of the nineteenth century by inventions favoring the defensive and many self-determination movements were successful. This article will trace the development of modern military technique as influenced by invention, the outstanding characteristics of that technique at the present time, and its present and potential political effects.

[1] This perhaps supports S. C. Gilfillan's insistence that inventions are usually made in response to a need. ("The Sociology of Invention," Chicago, 1935, pp. 10, 152.)

1. DEVELOPMENT OF MODERN MILITARY TECHNIQUE

"Until within the last few years," wrote Rear Admiral Bradley A. Fiske in 1920, "the most important single change in the circumstances and methods of warfare in recorded history was made by the invention of the gun; but now we see that even greater changes will certainly be caused by the invention of the airplane."[2] Modern civilization began in the fifteenth century with the utilization of the first of these inventions and has witnessed the steady improvement of this utilization through development of accuracy and speed of fire of the gun itself; penetrability and explosiveness of the projectile; steadiness, speed, and security of the vehicle which conveys it over land or sea toward the enemy; discipline and adaptation to such utilization of military organizations.

While the airplane continued this development by providing an even swifter vehicle for carrying the gun, it also introduced the third dimension into warfare, permittng the use of gravitation to propel explosives, far wider and more accurate scouting, and an extension of military action behind the front, over vast areas and across all barriers of terrain. Both of these inventions, after their use was thoroughly understood, greatly augmented the power of the offensive, though, in the case of the gun the defense immediately began to catch up and the general trend of war between

[2] "The Art of Fighting," New York, 1920, p. 361; see also Lewis Mumford, "Technics and Civilization," New York, 1934, p. 87.

equally equipped belligerents was toward a deadlock.[3] A similar tendency is already observable in the case of the airplane.

The history of modern military technique falls into four periods, each initiated by certain physical or social inventions and leading to certain military and political consequences—the periods (a) of experimental adaptation of firearms and religious war (1420–1648), (b) of professional armies and dynastic wars (1648–1789), (c) of industrialization and nationalistic wars (1789–1914), (d) of the airplane and totalitarian war (1914–).

(a) During the period of discoveries and wars of religion, medieval armor was being abandoned, pikemen, halberdiers and heavy cavalry were going, and the Turkish Janissary infantry, equipped with cutlass and long bow, well-disciplined and supported by light cavalry and artillery, were being copied throughout Europe. Heavy artillery had been able to reduce feudal castles and the "wagenburg" had revolutionized field tactics. The experience of the Thirty Years' War (1618–1648) ended this period of experimental adaptation of firearms by mercenary armies, and modern armies began to emerge.[4]

Naval architecture was greatly improved during this period. The clumsy galleons of the Spanish Armada, differing little from those of Columbus a century earlier, and resembling the oar-propelled galleys of the Middle Ages, were superseded in the mid-seventeenth century by longer, swifter and more heavily armed "broadside battleships" which differed little from those of Nelson, nearly two centuries later.[5]

[3] Fiske, *op. cit.*, p. 355.

[4] Charles Oman, "A History of the Art of War in the Sixteenth Century," London, 1937; Spaulding, Nickerson and Wright, "Warfare," London, 1924.

[5] S. C. Gilfillan, "Inventing the Ship," Chicago, 1935. The beginnings of this type were to be found in the ships with which Drake and Hawkins fought the Armada.

Equipped with the new technique of firearms, Europeans had occupied strategic points in America, Africa and Asia, readily overcoming the natives whom they encountered. The tendency of this new technique was toward political integration inside and expansion outside of Europe. By increasing the relative power of the offensive, firearms made it possible for the more aggressive rulers, especially those of Turkey, Portugal, Spain, France, Britain, Prussia, the Netherlands and Sweden, to expand their domains in Europe at the expense of feudal princes and to expand overseas at the expense of native chieftains.

(b) The seventeenth and eighteenth centuries witnessed the development of the professional army, loyal to the king and ready to suppress internal rebellion or to fight foreign wars if paid promptly, and if the officers were adequately rewarded by honors and perquisites of victory. Louis XIV and Cromwell contributed greatly to the development of this type of army, which, however, in the eighteenth century tended to be more concerned with safety and booty than with victory. Consequently, military invention emphasized defense and fortification. The art of war prescribed elaborate rules of strategy and siegecraft. Rules also dealt with the treatment of prisoners, with capitulations, with military honors and with the rights of civilians. The Prussian army with its vigorous discipline, aggressiveness and new strategic ideas under Frederick the Great to some extent broke through this defensive technique and brought this type of army to the highest point.[6]

The destructiveness of war was limited by the general exemption from the activities of land war of the bourgeois and the peasants, who constituted the bulk of the population. The bourgeois

[6] G. N. Clark, "The Seventeenth Century," Oxford, 1929; Spaulding, Nickerson and Wright, *op. cit.*; John W. Wright, *American Historical Review*, July, 1934, pp. 629 *ff.*; Richard Lewinsohn, "The Profits of War," pp. 28 *ff.*

were anti-military in attitude and of little influence in the politics of most states. The monarchs preferred to leave their own bourgeois and peasants to production, provided they paid taxes, and to recruit their armed forces from the unproductive riffraff, officered by the nobility, whose loyalty could be relied upon. With the existing techniques their armies could not easily attack the enemy's middle classes, unless his army was first destroyed and his fortifications taken. In that case such attack was unnecessary because these classes would usually accept whatever peace might be imposed. Lacking in patriotism or nationalism, they were little concerned if the territory on which they lived had a new sovereign provided they could retain their property.[7]

Navies reached the limit in size possible for wooden ships in the seventeenth century and underwent very little change until the steel ship developed 250 years later. The problem of adequate raw materials for war instruments was sharply presented in England during the latter part of this period as a shortage of oak for the hull beams, and of huge pines for the masts developed. The United States profited in the Revolution by blocking the British from their Canadian supply of mast timber. The British never met this problem by a consistent policy of planting until after the Napoleonic Wars, when the oaks were planted too late to become ripe until wood was superseded by steel in shipbuilding.[8]

(c) The French revolutionary and Napoleonic period developed the idea of the "nation in arms" through revolutionary enthusiasm and the conscription of mass armies.[9] The idea of totalitarian war was developed in the writings of Clausewitz, rationalizing Napoleonic methods. After these wars, the issue between professional, long-service, aristocratically officered armies and conscript, short-service, democratic armies was debated on the continent of Europe with a general relapse to the former type during the long peace of Metternich's era. The rise of nationalism, democracy and industrialism, and the mechanization of war in the mid-century reestablished the trend toward the nation in arms and totalitarian war.[10]

The use of steam power for land and water military transportation developed in the first half of the nineteenth century and was given its first serious test in the American Civil War. Moltke appreciated the military value of these inventions and his genius in using railroads for rapid mass mobilization won Bismarck three wars with extraordinary rapidity against Denmark, Austria and France. The ironclad and heavy naval ordnance were also tested in the American Civil War. The era of military mechanization progressed rapidly, adding greatly to military and naval budgets and to the importance of national wealth and industry in war. The new methods were given a further test in the Spanish-American, Boer, and Russo-Japanese wars.

The great nineteenth century naval inventions—steam power, the screw propeller, the armored vessel, the iron-hulled vessel, heavy ordnance—were at first favorable to British maritime dominance because British superiority was more marked in iron and coal resources and a developed heavy industry than in forests and wooden shipbuilders. But this advantage did not continue. The new battleships were more vulnerable than the wooden ships because ordnance gained in the race with armor, and re-

[7] Hans Speier, *Social Research*, 1936, vol. 3, pp. 304 *ff*.

[8] Robert C. Albion, "Forests and Sea Power," "The Timber Problem of the Royal Navy, 1652–1862," Cambridge, 1926.

[9] Hoffman Nickerson, "Can We Limit War?" Bristol, 1933, pp. 111 *ff*.

[10] A. F. Kovacs, "Prussian Military Legislation," Manuscript Thesis, University of Chicago, 1934.

pair at sea was impossible. Furthermore, the mine, torpedo, submarine and airplane added new hazards to the surface fleet, especially in the vicinity of the enemy's home bases. Warships, therefore, became more dependent upon well-equipped and secure bases for fueling and repair, and approach to even a greatly inferior enemy became hazardous. With the industrialization of other powers and their development of naval strength, Britain found it increasingly difficult to maintain a three or even a two power superiority in the ships themselves, while their distant bases became less secure.[11]

Britain abandoned the effort to dominate the Caribbean after the Venezuelan controversy with the United States in 1896, acquiesced in American seizure of the Spanish islands and agreed to an American fortified Panama Canal. It also welcomed American acquisition of the Philippines and in 1902 made an alliance with Japan, indicating doubt of its capacity to maintain its Far Eastern position by its own forces. The entente with France indicated awareness that British Mediterranean interests could no longer be defended single-handed.

Britain thus recognized that the development of naval techniques had tended toward a regionalization of sea power, and as a result it reduced its commitments for unilateral sea control from the seven seas to those seas controllable from bases on the British and Portuguese isles and from Gibraltar, Suez and Singapore. The far-flung British empire, the highways of the Mediterranean, the Caribbean and the China Sea and the Pacific could no longer be defended by the British navy alone. They must be defended by the dominions themselves and by alliances and friendships, especially with the United States, France and perhaps with Japan. It was clear that the British capacity to maintain reasonable order, respect for law and commercial obligations, and to localize wars by maintaining the balance of power in Europe had been greatly reduced. Naval inventions and the spread of industrialization had ended the Pax Britannica.[12]

This situation was realized by the continental powers, who developed their armies and navies with increasing speed after observation of the Russo-Japanese war, and after the failure of the Hague Conferences to achieve disarmament. They paid particular attention to the potentialities of the improved rifle, machine gun and artillery, as well as to the art of entrenchment.[13] The possibilities of the mine, torpedo and submarine were developed, especially by France, pointing the way for German utilization of these weapons in the World War. Beginnings were made, especially by France and Germany, in the adaptation of the airplane and dirigible to military purposes. The results anticipated by the Polish banker, Ivan Bloch, in his book written in 1898, occurred. War became deadlocked in the machine gun lined trenches, in the mined and submarine infested seas of the World War. This deadlock was not broken until attrition had ruined all the initial belligerents, and new recruits and resources on the Allied side from the United States made the cause of the Central Powers hopeless.[14]

[11] J. P. Baxter, "The Introduction of the Ironclad Warship," Cambridge, 1933; Bernard Brodie, "Major Naval Inventions and Their Consequences in International Politics, 1814–1918," Manuscript Thesis, University of Chicago, 1940.

[12] Q. Wright, *American Journal of International Law*, July, 1940, vol. 34, pp. 410 *ff*.

[13] Lt. Col. Azan, "The War of Position," Cambridge, 1917. Introduction; Admiral Fiske, *op. cit.*, pp. 355–59.

[14] While the capacity for coordination which was perhaps greatest in Germany because of her discipline and the fact that she had the interior lines, and least for Russia among the great powers, accounted for the prior breakdown of the latter, the quantity of resources to draw upon,

The advent of aerial war in the twentieth century ended the relative invulnerability of the British Isles to invasion. The weakening of surface control of the sea by the use of mines, submarines and airplanes further impaired the position of Great Britain and that country during the 1920's accepted the thesis that the integrity of the empire depended upon collective security. The possibilities of the airplane and tank, neither of them fully exploited during the World War, supported hope in some quarters and fear in others that the power of the offensive would be increased, that mobility in war would be again possible, and that the deadlock would be broken.[15]

These possibilities encouraged aggression by Japan, Italy and Germany after 1930. Dissatisfaction with the political results of the first World War, resentment at the self-centered economic policies of the democracies, serious deterioration of the middle classes and the spread of revolutionary ideologies engendered by the costs of war, widespread unemployment flowing from the great depression of 1929 provided motives for aggressions, but if collective security had been better organized and the airplane and tank had not been invented, the prospects would hardly have been sufficiently encouraging to induce action. As it was, the initial success of Japan in Manchuria and the failure of the disarmament conference, alarmed the Soviets into rapid rearmament and encouraged Italy and Germany to do likewise, especially in the air. Initial failure of the democracies to support the treaty structure when Germany began to rearm and to reoccupy the Rhineland in violation of international obligations, encouraged these states to consort together and to continue aggression in weak areas utilizing aviation with rapid success, while all phases of the national life were organized for total war.[16]

This development of militarism, totalitarianism and aggressiveness was most completely exhibited in Nazi Germany. Here the reaction from military defeat had been intense, confidence in technical ability to develop mechanized war was great, the economic situation was particularly grave, and the extreme democracy of the Weimar Constitution made government weak. In the background, however, the foundations had been laid by the historic rise of Prussia through war; the methods of the Great Elector, Frederick the Great, and Bismarck; the philosophies of Fichte, Hegel, Nietsche; the historical interpretations of Mommsen and Treitschke, and the geopolitics of Ratzel and Haushover.[17] Similar developments had begun in England under Cromwell and in France under Louis XIV and Napoleon at times when new military techniques, the disciplined use of firearms, superior coordination of

which was less for Germany than for her enemies who held the exterior lines, accounted for Germany's ultimate defeat. The discouraging influence which quantitative comparisons must have had on the German command after American entry into the war can be appreciated by a study of the data in Leonard Ayres's statistical summaries "The War with Germany, a Statistical Summary," Washington, 1919.

[15] General Douhet of the Royal Italian Air Force seems to have initiated the idea (of obvious propaganda value to a state planning to expand by military bluffs, whatever its military value) that victory can only be won by attack which under modern conditions is only possible by air; that surface defense should be only to facilitate air attack; that adequate air forces can soon gain "command of the air"; that, once gained, this command, if ruthlessly exploited to attack the enemy's big cities, can so break the enemy's morale that he will surrender. (See Lieut. Col. P. Vauthier, "La doctrine de guerre de General Douhet"; Dupuy and Eliot, "If War Comes," 1937, pp. 53, 60; Hart, "The Remaking of Modern Armies," pp. 96 *ff*.

[16] Speier and Kähler, eds., "War in Our Time," especially chapter on War Economics by E. Lederer, pp. 43 *ff*.

[17] F. Schuman, "The Nazi Dictatorship," New York, 1935; J. T. Shotwell, "What Germany Forgot," New York, 1940.

army and industry, mass mobilization through nationalistic propaganda, appeared to give these governments a strategic initiative. The strength of parliamentarism and reliance upon the navy stopped the trend in England, as in France did military defeats, the democratic sentiment of the revolution and the declining population of the nineteenth century. In the United States decentralized institutions, geographic isolation, and the democratic tradition have formed a barrier against militarism. In Japan, Italy and the Soviet Union, however, the circumstances of political ambition, economic frustration, imputations of racial, social or political inferiority, post-war disorganization and revolutionary ideas, when stimulated by hopes born of new military inventions, have tended in varying degrees toward military totalitarianism similar to that of Germany.

As the development of the gun by European great powers in the sixteenth and seventeenth centuries extended their imperial control to the overseas countries, followed by the latter's imitation of their techniques and eventual revolt, so the development of the airplane by the totalitarian states in the twentieth century first extended their empires and then compelled the democracies to adopt their techniques. Thus the great powers, whether with a democratic or an autocratic tradition, whether relying on the army or navy, whether European or American or Asiatic, have in a disorganized world felt obliged to follow the lead of that one of their number most advanced in the art of war.

The trend toward general militarization initiated by the gun was, however, checked in the eighteenth and nineteenth centuries through the rise of the naval, commercial, industrial and financial power of a relatively liberal and anti-military Britain; through the increasing indecisiveness and destructiveness of war; through the professionalization of the armed forces; and through the anti-militaristic philosophies of the rising bourgeois. It is possible that the position of the United States, the philosophy of peace and international organization, the economic cost of total war and perhaps the failure of aggression in the second world war may have a similar influence in the latter part of the twentieth century. In April, 1940, in spite of the success of Hitler's *Blitzkrieg* in Poland, Denmark and Norway, some military experts were predicting the failure of that method and the entry of the second world war into a long stage of attrition in which the superior morale, control of resources and manufacturing capacity of the democracies and the neutrals trading with them might eventually win the war.[18] It seems probable, however, that small nationalities can no longer defend themselves from powerful neighbors equipped with a vast superiority of planes. As the invention of artillery made it possible for monarchs to batter down feudal castles and build nations, so the airplane will destroy the independent sovereignty of nations and create larger regional units in their place. Whether there will be empires resting on conquest alone or federations resting on consent remains to be seen.

2. Characteristics of Modern Military Technique

(a) The outstanding characteristic in which modern war has differed from all earlier forms of war has been in the degree of mechanization. The use of long-range striking power (rifles, machine guns, artillery, gases), of power-propelled means of mobility (railroads, motor trucks, battleships, tanks, airships), and of heavy protective covering (armor plate on fortresses, tanks and

[18] Stephen King-Hall, *News Letter*, Supplement, 195, April 5, 1940.

warships) has meant that the problem of war manufacture has risen to primary importance.[19] In historic civilizations the soldier provided his own equipment, and it generally lasted as long as the soldier. Some equipment was lost, but even arrows could usually be collected in large numbers from the battlefield. Now a dozen men must be engaged in production and transportation services behind the lines to keep one soldier supplied.[20]

(b) A second important change has been in the size of armies, both absolutely and in proportion to the population. It might seem that if each soldier needs such a large amount of civilian help there would be fewer soldiers, but this has not proved to be the case. Power transport and electrical communication have made it possible to mobilize and control from the center a much larger proportion of the population than formerly. Men can be transported rapidly by railroad and motor lorry, and canned food can be brought to them. Thus where formerly one per cent. of the population was a large number to mobilize, now over ten per cent. can be mobilized, of which a quarter may be at the front at one time. But ten per cent. mobilized requires most of the remaining adult population to provide them with the essentials for continuing operations. Thus instead of one per cent. engaging in war and the rest pursuing their peacetime occupations of trade or agriculture, now over half of the entire population must devote itself to direct or indirect war service.

(c) A third change, consequent upon the second, has been the military organization of the entire nation. The armed forces have ceased to be a self-contained service apart from the general population. The soldiers and sailors must be recruited from those men whose services can be most readily supplied by women, children and the aged. The experts in transportation and industrial services must be largely exempted in order that they may continue their "civilian" services which, under modern conditions, are no less essential to war. Such a gearing in of the agricultural, economic and industrial population to the armed forces requires a military organization of the entire population. Since the perfection of such an organization after the outbreak of war has been impossible, the conditions of war have more and more merged into those of peace. The military organization of the entire population in peace has become necessary as a preparation for war.[21] The development of modern military technique has, therefore, tended toward the military state.[22]

(d) A fourth change, characteristic of modern military technique, has been the extension of government into the control of economy and public opinion. The military state has tended to become the totalitarian state. Other forces of modern life have, it is true, had a similar tendency. Democracy, under the influence of nationalism, has induced the individual to identify all phases of his life with that of the state, while state socialism, under the influence of depression,

[19] Friedrich von Bernhardi, "On War of Today," London, 1917, vol. 1, chaps. 3, 4; Engelbrecht and Hannighan, "Merchants of Death," New York, 1934, chap. 1. Pecuniary profits of war have shifted from the direct plunder or reward of the general, privateer, soldier and sailor to the indirect gains of the war financier, war trader, war manufacturer, war contractor and war speculator. Richard Lewinsohn, *op cit.*, pp. 115, 300.

[20] Adam Smith, "Wealth of Nations," book 5, chap. 1; J. M. Clark, W. H. Hamilton and H. G. Moulton, "Readings in the Economics of War," Chicago, 1918, pp. 93 *ff.*, 112 *ff.* Hans Speier, *American Sociological Review*, 1939, vol. 4, p. 374.

[21] Hans Speier, *loc. cit.*; Frieda Wunderlich, Labor in War Time, in Speier and Kähler, eds., *op. cit.*, pp. 245 *ff.*

[22] Hans Speier, *Social Research*, 1936, vol. 3, pp. 304 *ff.*

has induced the state to intervene in all phases of the life of the individual, but the needs of modern war have led and accelerated the process.[23] Modern war has required propaganda to sustain morale among the civilian population which, contributing directly to the war effort, can no longer expect to be exempt from attack. Modern war has also required an adjustment of the nation's economy to its needs. A free market system, depending on profits, has proved less adequate than military discipline for reducing private consumption and directing resources and productive energy to war requirements. Since transition from a free economy to a controlled economy would be difficult in the presence of war, preparation for war tends toward such a change in time of peace. Furthermore, autarchy is necessary as a defense against blockade. The controls necessary to confine the nation's economic life to those regions whose resources and markets will be available in time of war must be applied before the war. The modern technique of war has, therefore, led to the autarchic totalitarian state and the elimination both of free economy and free speech.[24]

(e) A fifth change, characteristic of modern war technique, is the breakdown of the distinction between the armed forces and the civilians in military operations. The moral identification of the individual with the state has given the national will priority over humanitarian considerations. The civilian's morale and industry support the national will. Thus the population, manufacturing and transport centers have become military targets.[25] Since bombing aircraft and starvation blockades have made it possible to reach these targets over the heads of the army and fortifications, the principle of military necessity has tended to be interpreted in a way to override the traditional rules of war for the protection of civilian life and property.[26]

While distinctions according extensive exemptions to the noncombatants, the civilian population and the national economy may still be supported by reference to the sources of international law, the practice of war has tended to become totalitarian. Starvation, bombardment, confiscation of property and terrorization are considered applicable against the entire enemy population and territory, except in so far as practical dangers of reprisal and a desire to utilize the population of occupied areas may inhibit. The entire life of the enemy state comes to be an object of attack.[27] The modern doctrine of conquest even extends to the elimination of that population and its property rights in order to open the space it occupied for settlement.[28]

(f) A sixth characteristic of modern war technique has been a great increase in the intensity of military operations in time, and of their extension in space.

Operations of war have always had the object of concentrating a greater

[23] Walter Lippmann discussed, in 1937, various factors which had weakened liberalism since 1870, but concluded "There is only one purpose to which a whole society can be directed by a deliberate plan. That purpose is war, there is no other." ("The Good Society," p. 90.) In 1884 Herbert Spencer saw collectivism leading to "militant communities organized for a state of constant war" ("The Coming Slavery").

[24] Speier and Kähler, *op. cit.*

[25] John Westlake, Chapters on "The Principles of International Law," Cambridge, 1894, p. 273.

[26] Q. Wright, *Minnesota Law Review*, 1921, vol. 5, pp. 520 *ff.* For general discussion of doctrine of military necessity see Westlake, *op. cit.*, pp. 238 *ff.*; U. S. Rules of Land Warfare, 1914, Arts. 10–13.

[27] Rudolf Littauer, Enemy Property in War, in Speier and Kähler, *op. cit.*, pp. 279 *ff.*

[28] Arthur Feiler, in Speier and Kähler, *op. cit.*, p. 153. This radically changes the assumption on which arguments, such as that by Norman Angell ("The Great Illusion," 1911), against the utility of conquest were based.

military force than the enemy at a given point, the control of which is regarded as important. Such points might be fortified places, government or commercial centers, transport and communication gateways, or a battle-ground selected by the enemy or one to which his forces might be lured. The party with inferior forces would try to delay action while he brought up reserves and improved his trenches, but if one acquired marked superiority at any moment he would usually begin a battle or siege. This episode would end in retreat or surrender by one side after a day or, in the case of siege, after several months and would be followed by months or years of maneuver during which another point of importance would emerge, forces would be concentrated, and another battle or siege would occur. The campaigns would thus be broken into distinct and separate episodes but, because of the slowness of communication and the difficulties of winter fighting, campaigns in separated areas or in different years would be, in considerable measure, isolated from one another. War typically consisted of a number of distinct campaigns separated by long periods and wide areas of relative peace.

The inventions in mechanization and mobility, the organization of the entire population, the increase in the number of important targets for attack, has made it possible to concentrate enormously greater forces at a chosen point, to supply reserves, and to continue attack and resistance at that point for a much longer period, to increase the number of points being attacked simultaneously, to enlarge the theater of the campaign by mutual efforts at outflanking, and to coordinate operations on all fronts, at all seasons, for the entire course of the war. The result was that the World War of 1914 tended to become a single and continuous campaign, and the campaign tended to become one long battle or a series of battles so overlapping and united as to be hardly distinguishable.[29] The pattern of war, instead of a grouping of dots on a map, became a large black spot of ink on the map which spread rapidly until the entire map was blackened. While this pattern was not at first duplicated in the hostilities which began in 1931, the new *blitzkrieg* and siege tactics may eventuate in an intense, continuous and universal battle. The continuous bombardment of London indicates such a development.

These six characteristics of modern military technique—increased mechanization and size of armed forces, more general militarization and nationalization of the people, greater extension and intensity of operations in regard to objectives, duration and theater—collectively tend toward totalitarian military organization of the belligerents and totalitarian military operations during the war. Though a trend in this direction began in the sixteenth century, it has been more and more emphasized during the past fifty years, with a marked acceleration during the past decade.

These changes have been most marked in the characteristics of weapons, less marked in that of organization and operations, and of little significance in the fields of policy and stategy. The art of using superior preparedness and a reputation for ruthlessness and threats of war for bloodless victory are as old as Machiavelli, though the vulnerability of civilians to bombing aircraft may have increased the effectiveness of these methods against nations which have greater potential power than the threatener.[30]

Writers on modern strategy can still draw lessons from the campaigns of Hannibal, Caesar, Frederick and Napoleon.

[29] The war of position is well described by Lt. Col. Azan, *op. cit.*, pp. 5 *ff*.

[30] H. Simons, Power Politics and Peace Plans, and Max Ascoli, Peace for Our Time, in Speier and Kähler, *op. cit.*, pp. 19 *ff*., 348 *ff*.

The importance of a clear *objective*, of seizing *offensive* opportunities, of striving for *mobility* are still important. The principles of *surprise, concentration, cooperation* or team work, *economizing of forces* through flexibility and maneuver, *security* of bases and positions continue applicable, though the conditions of their application have greatly changed.[31] The number of points on the earth's surface vulnerable to military surprise has been increased by the airplane, as has the quantity of force which may be concentrated at a point, and the possibility, afforded by electrical communication, of cooperation over a large area. The possibilities of maneuver, while increased in strategy, because of new means of mobility, has decreased in tactics, because of the larger forces engaged and the increased difficulties of outflanking. While all bases have become more vulnerable to surprise attack, the possibility of holding positions has not greatly changed. The arts of fortification, entrenchment and anti-aircraft defense have progressed with the progress of artillery and aviation.

Because of these changes some writers have asserted that there has been a change in basic strategic principles. It has been said, for instance, that the general objective of war is no longer to disarm the enemy by destroying or capturing fortifications and armed forces, but to evade them and to strike at the government or economic nerve centers of the enemy directly. Such a change in objectives, it has been thought, might modify the principles of concentration and security.[32] It appears, however, that recent wars do not support this theory. The old principles continue to be observed under the new conditions. The *blitzkrieg*, using airplane and tank, still aims at disarming of the enemy, though destruction of airdromes, communication and transportation centers, and lightening mechanized invasion, are, under modern conditions, the first step in this process.[33]

3. Political Effects of Modern Military Technique

Contemporary war appears to have made for instability, political disintegration, dictatorship and unadaptability. A final evaluation of the political effects of the most recent development of military technique must await the result of the second world war. The influence of these techniques upon the disposition of statesmen to threaten or to resort to war, and upon the political effect of such action can, however, be already observed and such observations seem to support our general analysis of the rôle of war in contemporary civilization. Four conclusions seem justified.

(a) Nations skilled in modern military techniques have an overwhelming advantage over those not so skilled.[34] This was manifested in the tremendous advantage of European nations which first began to adopt modern military techniques over the American and Asiatic states opened to them by the discoveries of the fifteenth and sixteenth centuries. The spread of

[31] Major General Sir F. Maurice, "Principles of Strategy," New York, 1930; Col. J. F. C. Fuller, "The Reformation of War," 1922, pp. 28 *ff.*; Rear Admiral Bradley A. Fiske, *op. cit.*, pp. 345 *ff.*

[32] *Supra*, note 15.

[33] Henry J. Reilly, *Foreign Affairs*, January, 1940.

[34] Adam Smith pointed out in 1776 that "In ancient times the opulent and civilized found it difficult to defend themselves against the poor and barbarous nations. In modern times, the poor and barbarous find it difficult to defend themselves against the opulent and civilized. The invention of fire-arms, an invention which at first sight appears to be so pernicious, is certainly favorable both to the permanency and to the extension of civilization." (*Op. cit.*, book 5, chap. 1, conclusion.) See also, Liddell Hart's conclusions on the Italo-Abyssinian war (1935) in which the Abyssinians had almost no defense against air and gas attack and his conclusions on the Spanish civil war (1937). "Europe in Arms," New York, 1937, pp. 251 *ff.*

European imperialism followed. With the development of these techniques in the United States, Japan and other overseas states, the European empires have been seriously shaken. The accelerating development of the modern techniques in the last ten years, however, has given rise to new differentials. Consequently, all states have felt obliged to move in the direction of totalitarianism and to equip themselves with the latest devices or to place themselves under the protection of states so organized and equipped.

(b) Modern military techniques, however, have increased the probability of a deadlock and a war of attrition between powers which are equally skilled in the use of these methods. Experience with an inflexible technique tends to favor the defensive, and highly mechanized techniques tend to become inflexible. The success of the offensive depends in large measure upon surprise,[35] and as the varied applications of a given technique become known, the opportunities for surprise become less. On the other hand, the defensive depends upon knowledge of the best means of dealing with the enemy's offensive and this knowledge steadily accumulates with experience of a given technique.[36] This is true of any form of conflict, whether with a serious objective or for sport. In the hands of experts, chess is far more likely to result in a draw than in the hands of amateurs, and football has shown the same tendency, with the result that the rules have been frequently changed to favor the offensive and keep the game interesting.[37]

[35] "Rapidity of movement and surprise are thus the life and soul of the strategical offensive." (Vonder, Goltz, "The Conduct of War," London, 1908, p. 54). Fiske, *op. cit.*, p. 40.

[36] "The modern tendency to keep up the international *status quo* arises from the great age of all European states. This sentiment naturally fits in with the spirit of the strategical defensive, the principle of which is likewise that of keeping up the *status quo*." (Vonder, Goltz, *op. cit.*, p. 63.

[37] Q. Wright, "The Causes of War and the Conditions of Peace," pp. 49 *ff.*

While the rapid progress of military invention during the past fifty years has provided opportunity for new surprises, on the whole it has tended toward more mechanization and capitalization of military technique favoring the war of attrition.

Furthermore, the masses involved in a major modern battle have become so large that they cover the entire front. No maneuver can get around the flanks of an enemy whose line extends along the entire frontier.[38] The *blitzkrieg* coordinating plane, tank and infantry broke through at the weakest point when assisted by the element of surprise and great superiority of material.[39] The aerial bomber with its power of hitting the enemy's nerve center directly may break the deadlock. The airplane has undoubtedly made the civilians and the national economy vulnerable to attack. The fear of reprisals is the civilian's only defense from aircraft.[40] But to say that each side can destroy the other's civilians and cities does not say that rapid victory can be won by doing so if there is comparative equality of planes and productive capacity. Under such conditions war may continue in the course which Bloch predicted and the World War demonstrated, toward mutual attrition.[41]

[38] Col. J. F. C. Fuller, *op. cit.*, p. 83. See also J. Holland Rose, "The Indecisiveness of Modern War," London, 1927, p. 47; Liddell Hart, *Atlantic Monthly*, December, 1936.

[39] This was to some extent anticipated in England. Fuller, *op. cit.*, chap. 8; Nickerson, *op. cit.*

[40] British Prime Minister Baldwin said that against air attack "the only defense is offense, which means that you have to kill women and children more quickly than the enemy if you want to save yourselves" (quoted by B. Russell, "Which Way to Peace," p. 21, who quotes to similar effect Brigadier General Graves, "Behind the Smoke Screen," and Air Commander Charlton, "War from the Air," 1935).

[41] Bloch, "The Future of War," pp. 347 *ff.*; J. Holland Rose, *op. cit.*; Fuller, *op. cit.*, chap. 4. The question is still controversial. See Nickerson, *op. cit.* Hostilities in Spain and China suggested that anti-aircraft defense had progressed more rapidly than air attack. The

(c) The skills involved in modern military techniques tend to be less the capacity to command armed forces in the field than the capacity to manage the national economy, to sustain the national morale, to destroy the enemy's morale and economy, and to handle neutrals diplomatically—in other words, the rôle of strictly military operations, in wars between states of equal technological development, has tended to decline. Wars were formerly won through military operations in the field and this is still true where a powerful state with the latest military techniques attacks one smaller, more backward, or less prepared. States may, however, fail to win wars over their technological equals, even though they win most of the battles. With the totalitarianization of war the cost of winning battles may make them Dead Sea fruit to the victor.[42] With this development, economic strength, propaganda strength and diplomatic strength have increased in relative importance.[43] After both sides have been ruined, the coalition controlling most population, raw materials, industrial equipment and civilian morale may win because the other has run out of one of these items and the control of sea-borne trade may continue a major factor in lasting capacity.[44] The significance of propaganda has been illustrated in the policies of Hitler and Mussolini.[45] Bismarck recognized the importance of the imponderables in war, and the superior diplomatic ability of the Allies in winning neutrals contributed greatly to their success in the World War. Rapid military victory may in fact prove a positive obstacle to diplomatic success. Neutrals, not too close to the scene of action, are likely to fear and distrust the government so well prepared that it wins initial military successes. For this reason, as well as from sympathy to the victim of invasion and a desire to restore the balance of power, such neutrals may give moral or even material support to the government which loses the first round.[46] Neutrals near to the initial victor tend, however, to jump on his bandwagon.

(d) The utility of military power has become distinct from the utility of military victory. As an instrument of policy, war is more useful because of its nuisance value than because of its capacity for positive achievement. It is like the bomb in the hands of a bank robber, which if tossed will destroy both bank

Albanian, Polish, Danish, Norwegian and, in a less degree, the Finnish campaigns of 1939–40 demonstrated the possibilities of the Blitzkrieg against an inferior enemy. (See Henry J. Reilly, *Foreign Affairs*, January, 1940, pp. 254 *ff.*; J. M. Spaight, *ibid.*, pp. 357 *ff.*) Similar methods proved successful against France. (Hoffman, Nickerson, *Harper's*, August, 1940, pp. 239–48.) For difficulties of this type of war against an enemy of vast area and population like China see Kurt Bloch, Institute of Pacific Relations, *Inquiry Series*, 1939, pp. 43 *ff.*, quoting W. Schenke, *Zeitschrift für Geopolitik*, 1938, pp. 705 *ff.* See also R. E. Dupuy, *Pacific Affairs*, June, 1939, pp. 138 *ff.*

[42] See James T. Shotwell, *op. cit.*, pp. 144 *ff.*

[43] In distinguishing the military, economic and propaganda fronts in war, H. D. Lasswell ("Propaganda Technique in the World War," London, 1927, pp. 9, 214) follows Clausewitz, who wrote: "There are principal objects in carrying on war, (a) to conquer and destroy the enemy's armed forces, (b) to get possession of the material elements of aggression, and of the other sources of existence of the hostile army, (c) to gain public opinion." (Major Steward L. Murray, "The Reality of War," London, 1914, p. 69.)

[44] Admiral A. T. Mahan, "The Influence of Sea Power on History," 1660–1783, 1899.

[45] H. D. Lasswell, *op. cit.*, p. 214. See also Admiral Hussey, "The United States and Great Britain," Chicago, 1932, p. 206. Military men have always realized "that in war we have to do not so much with numbers, arms and manoeuvres, as with human nature" (Henderson, "Lessons from the Past for the Present," quoted by Dupuy and Eliot, *op. cit.*, p. 41), but they have emphasized propaganda to increase the morale of our troops rather than to destroy that of the enemy.

[46] Q. Wright and Carl J. Nelson, *Public Opinion Quarterly*, 1939, vol. 3, pp. 49 *ff.*

and robber but which when threatened may induce the cashier to comply with demands peacefully. War is still in practice, if not in law, an instrument of national policy, but other instruments such as diplomacy, commercial pressure, propaganda or the invocation of international procedures are now available. These methods are used as auxiliaries to military attack, but they also constitute alternative methods which may be used for achieving policy.

The threat value of war as an instrument of policy may even have an inverse relation to its actual value as an instrument of policy. The excessively high costs of war have added to its nuisance value in the hands of adventurous statesmen. In proportion as war means ruin for all if actually resorted to, more responsible statesmen will tend to yield to the demands of those who threaten it. The bombing airplane, directly threatening civilian populations, has been particularly useful as a support for diplomacy and was doubtless largely accountable for the successes of Mussolini and Hitler in warding off intervention by England and France in the cases of Ethiopia, Spain, Czecho-Slovakia and Albania. In these cases war potential rather than war itself served as an effective instrument of national policy.[47] Since, however, the diplomatic use of war potential may easily result in war itself, destructive to the policies of all participants if not to civilization, there is a general interest in eliminating that use. Not only resort to war, but even more a threat of war should be regarded as a crime. It can not be said that Hitler's threat of war at Munich, in September, 1938, was any less criminal than his use of war in Poland in September, 1939.[48]

Modern military technique has centralized world power in the governments utilizing it most efficiently, has made war suicidal among those powers, has diminished the rôle of strictly military activity in war, and has augmented the nuisance value of war threats to the unscrupulous.

4. The Future of Military Technique

In the past, cycles of war have tended to move from (1) the technique of agility and pounce to (2) the technique of momentum and mass charge followed by (3) the technique of discipline and maneuver which in time moves to (4) deadlock and the war of attrition.

The first two of these four stages have in past civilizations been dominated by the offensive spirit illustrated in the classical civilization before the time of Augustus (27 B.C.) and in Western civilization before the "Babylonian captivity" of the Papacy (1309 A.D.). The last two stages have been dominated by the defensive spirit. Rome expanded little after Augustus but defended its frontiers. Christendom did little crusading after Boniface but defended itself from Arabs, Turks and Tartars.[49]

A parallelism may, however, be detected between the offensive and defensive periods in that each began with reliance upon quality in its armies and ended with reliance upon quantity.

The military history of modern civilization exhibits analogies to these earlier civilizations. The highly trained but relatively small armies of the sixteenth, seventeenth and eighteenth centuries, capable of pouncing upon and paralyzing their enemies rapidly, especially when those enemies were Americans,

[47] F. S. Dunn, "Peaceful Change," New York, 1937, pp. 8 *ff*.

[48] Q. Wright, *American Journal of International Law*, 1939, vol. 33, pp. 12–33.

[49] The dates suggested for these dividing points are arbitrary. The end of medieval expansion might be pushed back to the fall of Acre in 1291, extinguishing the kingdom of Jerusalem or forward to the black death in 1348, which contributed much to the permanent elimination of the offensive spirit of medieval Christendom.

Asiatics or Africans without modern arms, grew gradually in size as populations increased and methods of transportation and communication improved. When at war with each other they relied more and more upon defensive fortifications and siegecraft, but their basic strategy and tactics continued with little change until the French revolutionary period.[50]

Napoleonic doctrine, built on universal conscription and the revolutionary spirit, held that military power varies mechanically as the product of the mass and the mobility of the army. This doctrine, however, emphasized morale even more than materiel and might have been formulated from this point of view, that military strength varies morally as the product of the zeal of the nation, and the perseverance of the army in the strategical and tactical offensive.[51] General acceptance of this doctrine of the nation in arms since the mid-nineteenth century may mark the transition to the second stage of modern warfare. National self-consciousness had been developed by Fichte, Mazzini and Treitschke,[52] and the doctrine of mass warfare had been developed by Clausewitz and his successors especially in Germany.[53] The practice of this type of warfare was facilitated by the use of the railroad for mass mobilization and of heavy mobile artillery for battering through. Its possibilities and tendencies were illustrated by the operations of Grant and Moltke, Kuropatkin and Oyama, Hindenburg and Foch.[54]

Throughout the entire modern period the doctrine of the strategic offensive has in general dominated.[55] Modern civilization was expanding on land and sea, and by the time of the World War it had superficially covered the globe. There were still nooks and corners in Africa, the Pacific and Asia where it had not penetrated, but in the main its task appeared to be no longer external expansion but internal reorganization and integration.[56]

The progress toward totalitarian war and the spirit of the offensive continues, but the war of 1940 differs from that of 1914 in its greater mechanization and greater reluctance to sacrifice masses of men in frontal attacks. While modern civilization, viewed in the large seems to be just passing from its "heroic age" to the "time of troubles," which in past civilizations has been characterized by an extraordinary development of mass warfare, this stage may be proceeding so rapidly that already signs are appearing of the third stage, that is, the war of maneuver with a defensive spirit and reliance upon the quality rather than the quantity of the army.[57]

It is worth notice that while Classical

[50] See *supra*, notes 6, 7.

[51] Nickerson, *op. cit.*, pp. 141 *ff.*; Liddell Hart, "The Remaking of Modern Armies," pp. 88 *ff.*

[52] On the rise of modern nationalism see C. J. H. Hayes, "Essays on Nationalism," New York, 1926; J. C. King, Some Elements of National Solidarity, Manuscript, University of Chicago, 1933, chap. 9.

[53] See works of Vonder, Goltz, Bernhardi, Freytag-Loringhaven cited. "The conduct of war . . . has generally been supposed to mean the direction of armies and navies and therefore a matter to be left to soldiers and sailors. To-day at least we should be aware that it means the direction for a special purpose of the whole power and resources of the nation." Major General Sir Frederick Maurice, "Governments and War," London, 1926, p. 123.

[54] See Rose, *op. cit.*, chaps. 1, 2; A. L. C. Moltke's Plans of Campaign, "The Military Historian and Economist," 1916, vol. 1, p. 297; Col. J. F. C. Fuller, *op. cit.*, pp. 75 *ff.*

[55] There was an exception in the eighteenth century with respect, however, only to European wars. Nickerson, *op. cit.*, pp. 114 *ff.*

[56] See Ramsay Muir, "The Expansion of Europe," Boston, 1923; P. T. Moon, "Imperialism and World Politics," and Schuman, *op. cit.*, pp. 93 *ff.* for description of the process by which Europe expanded over the world.

[57] Such a transition is anticipated by such military writers as Fuller, Liddell Hart, Nickerson, etc.

and Western civilizations each made such a transition in military techniques, the political consequences of the change were different in the two cases. Classical civilization having become politically organized in the universal state of Rome, the army became the police force of that state, efficiently defending its frontiers and preserving internal peace for over two centuries. In Western Christendom, on the other hand, Boniface's hope of a centralized control by a universal church, Dante's hope of a centralized control by a universal empire, and Dubois's hope of a centralized control in a universal federation of monarchs—all three expressed in the first decade of the fourteenth century—failed of realization.[58] The Holy Roman Empire and the Catholic Church were weakened by internal dissension. Mercenary armies served to defend Christendom, efficiently in Spain and inadequately in the Balkans, but they did not constitute the policy of a centralized Christendom. They were armies of the rising national states, not all of which were satisfied to defend existing frontiers. England had been expanding at the expense of Wales, Scotland and Ireland and was about to wage the Hundred Years' War of conquest against France, and then to endure the bitter Civil War of the Roses; Switzerland and Bohemia were to struggle for independence; Italian states were to engage in a series of struggles for ascendency in the Italian peninsula, as were Spanish states in the Iberian peninsula and German states in the empire. The *Pax Ecclesia* did not achieve so enduring an organization as did the *Pax Romana*. Western civilization declined in ceaseless internal wars of contending states and factions and steadily lost territory to the Turks, until it began to be absorbed by the rising world civilization, inaugurated by the discoveries, the inventions, the Renaissance and the Reformation.[59]

Proposals which have been made for a more scientific organization of peace and for a more scientific organization of war suggest the alternatives before the contemporary world. The offensive power of armies may be so much weakened through continuance of the nineteenth century trend, perhaps augmented by disarmament agreements and change of popular evaluations from the standards of national power to those of human welfare, that all will give up the hope of or interest in conquest, and an adequate world organization with an efficient police may be able to assure both collective security and peaceful change. Such a trend may be illustrated by the federal organization of the United States, Canada, Australia and other states, by the change of the Monroe Doctrine from a policy of the United States hegemony to the Good Neighbor and Pan-Americanism, by the change of the British Empire to a voluntary commonwealth of nations, and by the attempts at world union at the Hague and Geneva.[60]

On the other hand, national states may modify the techniques of their armies so as to favor the offensive, as suggested by recent experience with the *blitzkrieg*, and a period of balance-of-power wars may prevent the integration of such a collective system and tend toward a series of regional hegemonies. These might eventually reach a stable equilibrium, or one might conquer the rest and establish a world empire.

It can not be denied that the trend of military history since 1932 has looked toward a third alternative. On the one

[58] These proposals are summarized by Frank M. Russell, "Theories of International Relations," New York, 1936, pp. 99 *ff*.

[59] See Oman, "The Art of War in the Middle Ages"; "The Sixteenth Century," London, 1936.

[60] See Lord Davies, "The Problem of the Twentieth Century"; Russell, *op. cit.*, pp. 327 *ff.*; Clarence Streit, "Union Now," New York, 1939.

hand, states have adopted more extensive conscription laws, have maintained larger standing armies, have voted larger military appropriations, have provided more complicated frontier defenses and have striven for a higher degree of economic self-sufficiency, thus preparing for total war. On the other hand, they have utilized centralized propaganda instruments and economic controls to develop in each population a more fanatical and aggressive national spirit. The combination of these policies, which has precipitated the second world war, may tend toward frequent general wars on a gigantic scale and the eventual destruction of civilization.

This article has discussed the application of invention to war. But inventions are also applicable to peace. The railroad, steamship, motor car and airplane have shrunk travel and transport distances so that the world is no bigger to-day than was Europe in the time of Napoleon. The cable and radio have shrunk the communication distances so that the world to-day is no bigger than was a village a century ago. These inventions have brought all sections of the world into relations of economic, political and cultural interdependence. They have destroyed the security of geographic barriers and made every people vulnerable to propaganda, embargo and military attack. They have created both the possibility and the necessity for organizing the world as a whole for peace. What use will be made of inventions belongs, however, not to technology but to the human spirit.

SCIENCE SERVES ALL NATIONS

Too often increased knowledge of natural forces, acquired by scientific studies, has been employed in harmful as well as in beneficial ways. To these balanced consequences, good and evil, the consequences of medical investigations, as previously noted, are in striking contrast. It would be difficult, if not impossible, to find that any one of the many important discoveries made in the medical sciences during the past hundred years has been used by fighting forces for the destruction of life. . . .

There is another consideration eminently creditable to the efforts of medical investigators. Because life and health are precious and medical research is deeply concerned with protecting life and health, the triumphs of that research are put to use without regard to any national or racial difference. There is no escape from the succor which they bring. Even though the beneficiaries may despise their benefactors, they must receive the benefactions. Is a follower of the Fuehrer bleeding to death and desperately dependent on a blood transfusion? His life is saved by methods discovered by Landsteiner, once an Austrian. Does a Japanese complain of a bewildering dizziness caused by disturbance of the internal ear? He will be in debt to Bárány, a Hungarian investigator. Does an Italian doctor wish to know whether a patient has typhoid fever? He applies observations first made by Widal, a Frenchman. Is one of our children in danger of diphtheria? His resistance to infection is tested by a process invented by Schick. Goldberger, an immigrant to New York's East Side, provided a simple preventive and treatment of pellagra, which made possible lifting, from hosts of miserable people, the blight of that dreadful disease. And no matter in what country they may be, the tens of thousands of victims of syphilis must rest their hope of relief on a method of diagnosis first devised by Wassermann, and on a curative method discovered by Ehrlich, both Germans at a time when Germany recognized, without contempt and malignity, the value of ingenious devotion to human welfare. All these contributors to medical knowledge have been citizens of various lands, but they would all be classed as belonging to one people. And though in the last years their people have been again savagely and sadistically persecuted, no nations, however hostile, can take from these medical representatives the honor and glory of having served as saviors of their fellow men.—*Walter Bradford Cannon, in the symposium, "The University and the Future of America," at Stanford University.*

SARGASSO SEA MERRY-GO-ROUND

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I

STORY-TELLERS have created the illusion that the Sargasso Sea is a forbidding region of the tropical Atlantic, where wrecked and abandoned ships of all ages lie cluttered in one enormous, slowly rotating mass.

The Sargasso has become known as a sort of marine purgatory. According to romanticists hulks of broken, barnacled-covered galleons float, half-sinking, in the very center. Surrounding this decaying and weed-entangled core, skeletal keels of wretched African slave ships and the pirate ships of the Caribbean buccaneers make their monotonous rounds. Encircling these bloody ships come the unfortunate ships of the Revolutionary period, the once slow majestic windjammers, the once fast clipperships, the once sturdy whalers, now all weed-grown, slimy and disintegrating. Finally, on the outermost fringe of this sea-hell, circle the last remains of recent naval catastrophes. As long as these doomed vessels stay afloat they keep up a barely perceptible, yet never-ending parade in their circular marine limbo.

Geographers, too, have called the Sargasso a *sea*. But, in reality, it is not a sea, at least not a good example of a sea, like the Mediterranean, for instance. All good seas, geographically speaking, have land boundaries that set them off, for the most part, from the open ocean. No land boundaries confine the Sargasso Sea, for it lies within the heart of the Atlantic Ocean itself, a sea within a sea, like a hub within a wheel. As powerful oceanic currents and winds turn the watery wheel of the Atlantic round and round, the Sargasso hub turns within the wheel.

Seaweeds, not land boundaries, set off the Sargasso as a distinct area of the Atlantic. No other region on this planet, either on land or water, produces so great an acreage of a single species of plant. All the wheat fields of America put together are like back-yard gardens compared with the vastness of the Sargasso Sea, the home of Sargassum weeds. The extent of Sargassum's habitat is not measured in terms of acres, but by degrees of latitude and longitude. Picture a triangular marine garden bounded on the southwest by the Antilles, on the northeast by the Azores, and on the southeast by the Cape Verde Islands. These landmarks on the oceanic expanse denote a region of the sea, roughly, between the thirtieth and fortieth parallel of north latitude and between the thirtieth and seventy-fifth meridian, longitude—an area approximately the size of continental United States, some 2,500,000 square miles.

The barriers which confine the Sargassum weeds to their extensive, but nevertheless restricted, bounds are chiefly the great oceanic currents. The powerful Gulf Stream comes up from the south and flows along the western fringe of the Sargasso. It sweeps north and then east towards Europe. The Canary Current continues the relay race of the oceanic circuit by running south where it meets the North Equatorial Current, which, in turn, takes its charge to the province of the Gulf Stream and completes the circumfluence of the Sargasso.

Since the sea-fences around the Sargassum weeds are liquid forces, not solid barriers, it is to be expected that oceanic disturbances occasionally shift or break the circular marine zone that confines the plants. Rafts of floating Sargassum,

in freight-boat loads, have been swept northwest to Massachusetts and northeast to the coast of Europe. Almost ninety years ago, William Harvey, keeper of the herbarium of the University of Dublin, said that the Sargassum weeds have "no just claim on our flora, being native of the tropics, occasionally driven together with cocoa-nuts and other tropical productions by the force of the western currents on our Atlantic coasts." For years the hardy Scotch and Irish cattle herders have depended upon the adventitious harvest of this and other seaweeds as winter storms fringe their rocky coasts with free gifts of these valuable sea-vegetables. Perhaps those salt-encrusted husbandmen and their families do not mind the strong fishy flavor that seaweeds impart to the milk. At any rate, they are well compensated, for it is certain that few of them ever suffer from goiter; it is well known that these fucaceous algae, while pungent in flavor, are rich in beneficial salts, particularly iodine and potassium. With the return of normal climatic conditions in the Sargasso, the weeds are herded together again; they return to their circular parade within the confines of their sea-stream corral.

In spite of the liquidity of its barriers, the Sargasso Sea has characteristics, apart from its famous weeds, which set it off from the rest of the ocean. Its waters are relatively motionless, warm, deep blue in color, highly transparent and highly saline. Being at the hub of the ocean whirl, the Sargasso turns more slowly than any other part, although it seemingly turns hardly at all. Its waters are warm because they are located near the equator, and, in addition, they are surrounded by warm oceanic currents. The waters are deep blue, highly transparent and highly saline, all for the same reason, because the Sargasso is far from continental influences. By the time continental rivers that bring to the sea the run-off waters of melting snows and the wash of the land reach the vicinity of the Sargasso in mid-ocean, the river water is no longer fresh nor loaded with silt. The clarity of the water of the Sargasso is remarkable. United States oceanic expert, H. A. Marmer, says he could see a six-foot white disc at a distance of 200 feet below the surface. And that is nearly a perfect reading.

The deep-blue color is due to great depth of water, the lack of turbidity and the scarcity of microscopic marine life. The floating, pelagic, planktonic organisms are nowhere scarcer in the ocean than in the Sargasso. Except for the floating world of Sargassum weeds and their animal associates and dependents, the Sargasso is virtually a desert.

The power of the Gulf Stream to turn, not only the Sargasso hub, a mere 2,500,000 square miles, but the entire oceanic wheel is remarkable indeed. Here is how Marmer illustrates its stupendous power. The Mississippi River drains 40 per cent. of the United States; at flood time, when it has three times the normal flow, the Mississippi pours 1,800,000 cubic feet of water per second into the Gulf of Mexico. It would take close to 500 Mississippi Rivers, all flowing at once, at flood-stage force, to match the volume and power of the Gulf Stream.

II

The scientific game of cataloguing the species of Sargassum weeds has given botanists many headaches. William Randolph Taylor, the University of Michigan's expert algologist, who used to spend his summer vacations around the little inhabited coral reefs of Florida in his search for seaweed specimens, says that the dominant plant representative of offshore waters is *Sargassum natan* Meyen.

Sargassum represents, not one, but several kinds of weeds, all of which belong to the most primitive society of plants in the world, the Algae. Some

Sargassum weeds are attached to rocky shores by holdfasts; the free ends, supported by air bladders, rise and fall with the action of the tides. Their stems and branches are so tough and leathery that they can withstand the terrible beatings they constantly receive from the pounding waves. The famous wandering Sargassum weed, *natan*, of the open Sargasso Sea has no holdfasts. It lost its attachment organs long ago in geological time, but its stalks and branches have developed elaborately. To the layman, these parts of the lowly alga resemble, with amazing nicety, the stems and leaves of higher plants.

Many rock-bound Sargassum weeds are frequently torn from their island and continental attachments by extremely violent wave action. Living as fragmentary plants, they are carried out to sea by the Gulf Stream and often take up a wandering existence in the Sargasso. Many able botanists believe that the floating world of weeds in the Sargasso is made up entirely of such detached fragments, the supply of which is annually being replenished from the rich coastal seaweed crop. Sir John Murray, England's great oceanographer of the last generation, believed that this was the true source of supply. So did his compatriot, J. Arthur Thomson, who, in his "Biology for Everyman," said that the immense floating population of brown seaweeds constitutes a cemetery of dead and dying plants rather than a meadow of living plants. But the new school of oceanographers thinks that the bulk of the Sargassum weeds in the Sargasso is represented by a species indigenous to that region, one that has been born and lives its entire life in mid-ocean.

While it is true that the rock-grown species of Sargassum are frequently torn from their anchorage and, by virtue of their buoyancy, carried to the Sargasso, these straggling fragmentary plants are strangers to the gypsy life of the native wandering Sargassum weed. The rock-reared weed-immigrants may seem to enter into the spirit of Sargasso Sea life by joining the circular parade, but the landlubber plants can not tolerate the never-ending mid-ocean merry-go-round for long; eventually they die.

The native pelagic seaweed of the Sargasso is equally ill at ease when forced out of its circular course on the high seas by storms and carried to hard uncongenial shores. It is totally unsuited to a sedentary life; it has no holdfasts with which to cling to the rocks, and it can not develop them. It is unable to live the life of an exile on any land. It is as helpless as a ship run aground; like a helpless ship, it is pounded to pieces and its parts are cast upon the shore.

The wandering and the sessile Sargassums are different in other habits of life, for the wanderer is a sterile species producing neither sperms nor ova; the sedentary weeds are fertile and reproduce in the approved biological manner. Professor A. E. Parr, Yale's Sargasso expert, says that the pelagic Sargassum has so unique a method of self-preservation that the word for it has not yet been invented. This plant does not reproduce itself by runners, tubers, buds or spores. In fact, it has no true reproduction at all; it simply grows at the tips and dies down at the base.

Over a hundred years ago, in 1830, Meyen, the botanist, said that the pelagic Sargassum was a sterile species, that it grew only at the tips. He claimed then that it was an independent plant and not one brought in by the Gulf Stream. Thus, in the fashion of the circular movement of the Sargassum weeds themselves, biologists have returned to an idea held many years ago.

From earliest times to the present, students of oceanic life have guessed at the quantity of weeds in the Sargasso. Oceanographer Parr has taken on the job of finding a better answer. On his expeditions to the Sargasso, and he has

directed three of them, he takes along a unique gadget, a specially designed Sargasso weed sampler. This device, when towed behind the ship, cuts exactly two-foot strips of the surface weeds. From the mountainous mass of figures that he has collected from the hauls made by the sampler in 3,000 miles of the Sargasso, Parr is willing to say that there are about 10,000,000 tons of seaweed in the Sargasso Sea.

Ten million tons of weeds would make an impressive pile, but when it is realized that the weeds are spread over a field of 2,500,000 square miles, the figure is less impressive. When the figure is reduced to terms of pounds per acre, the values are quite disappointing. It turns out that the Sargasso produces one and one-half pounds of seaweeds per acre. That is why the Sargasso is regarded as an oceanic desert by biologists; for, not only does the water of the Sargasso support relatively little microscopic life, but its main crop, seaweeds, is low in terms of yield.

III

In the popular mind, even to-day, the concept of the Sargasso Sea as a weird and horrid place is strong and widely prevalent.The growth of this romantic notion of the Sargasso is, in itself, a long and an exciting story.

On Sunday, the 16th of September, 1492, after eight continuous days at sea, Christopher Columbus discovered the floating world of the Sargasso. When 800 miles west of the Canary Islands, Columbus remarked that around their ship they found "much green floatage of weeds" which, to them, seemed like an endless prairie. The weather was pleasant and "the mornings were most delightful wanting nothing but the melody of nightingales."

The caravels ploughed through the marine prairie with ease for two days; then the ships met with "alternate changes of wind and calms." Columbus continued to see large quantities of weeds, "such abundance of weeds that the ocean seemed to be covered with them," and after three days of idleness in the Sargasso, the Admiral was forced to write: "My crew has grown much alarmed, dreading they never should meet in these seas with a fair wind to return to Spain."

Some among Columbus's men first thought that the seaweeds indicated submerged rocks and feared going aground, but they must have been reassured on this point, for their longest plummet-line was unable to reach bottom. Yet the sight of the ever-present weeds, without the accompanying sight of land from which the rock-weeds, as they knew them, were supposed to grow, seemed uncanny. It was this disturbing scene, thinks John Fiske, in his straightforward history of the "Discovery of America," that revived the mariners' ancient fancies that they had arrived at that mysterious and impassable region of the Atlantic where ships are held fast in long entangling sea plants.

These legends of weed-cluttered impassable seas are ages old; they were 1,800 years old in Columbus's time. They go back to the times of Aristotle and his ancient geographies. One weed-strewn region was supposedly situated south of the Canary Islands and west of the Rio d'Oro off northern Africa. According to ancient beliefs, this region was situated somewhere on the edge of the western ocean, on the edge of the world as known in those days. The legends told of overbold sailors that dared to approach too close to these weedy areas. Some escaped with difficulty, others, entwined beyond their power to retreat, remained enmeshed and perished.

Of course there were skeptics. Columbus was one of them. Those who scoffed at these legends declared that the tales were kept alive simply to frighten masters of trading vessels from competing

for the lucrative Atlantic coastal shipping business. Cyrus Adams thinks that the Phoenician sailors' story of the "sea grass in the Atlantic, with pointed tops as sharp as needles and stalks as close together as wheat in the sheath, so that vessels could not stir if caught in it" was one of the best of early publicity stunts.

Yet one can easily appreciate the disquietude of Columbus's men. It was now eleven days since they had seen the green land vegetation and heard the shrill song of the wild Canary birds. Their ships were small and frail; two vessels had uncovered decks, open to the full force of the burning sun.

One man in recent times fully appreciated Columbus's predicament. He is G. F. Simmons, who led the Cleveland Museum of Natural History expedition into the Sargasso Sea on a specimen-collecting voyage on an old windjammer in 1927. This modern Sinbad of science says he could easily understand why the Sargasso Sea is shot with wild tales, for he and his companions were held in the weeds of the Sargasso under a blazing sun for more than a week, held, not by the weeds themselves, but by the lack of wind or current to take them away.

Columbus was destined to sail almost twenty days more before he, himself, detected, at two o'clock in the morning, a glimmer of light from a "small island, one of the Lucayos, called in the Indian language *Guanahani.*" It was Friday, October 12, 1492. Columbus had discovered America.

IV

From Columbus's time to the present, strange conflicting stories of the Sargasso Sea have been told. Fernando Colon, in the history of his father's life, drew a dramatic picture of the great discoverer's difficulties in the Sargasso. Oviedo, in his "Historia," and Petros Martyr, in his version of the voyages, intimated that the masses of seaweeds encountered by Columbus were so dense that they impeded the progress of the ships. Later-day observers added a little to our true knowledge of the Sargasso, but the commentators on scientific topics added much to the store of fables concerning it.

James Barbot was master of a ship that passed near to the Sargasso in 1700. In his log book this pertinent item appears for a day in June, the seaweeds were seen "for a space of forty or fifty leagues and so close and thick together in some places that a ship requires a very fresh gale of wind to make her way through; and therefore, we are very cautious to avoid them in our course."

To America's first outstanding oceanographer, Matthew Fontaine Maury, the Sargasso appeared, at a little distance, so thickly covered with gulfweeds that it seemed substantial enough to walk upon. Maury gained international fame as one who first charted the winds and ocean currents of North America. He is regarded by many as the father of the United States Naval Academy, yet, during the Civil War, he served the Southern States. He accurately visualized the cause for the almost perpetual calm of the Sargasso, and he is credited for a simple explanation of its movement and the reason for its location.

Take a basin of water, he said, and put into it some slips of wood, soapsuds and other flotsam. Then impart a circular motion to the water with a sweep of the hand and watch the result. The floating matter will almost directly gather into the very center of the basin, where the movement is the slightest, while the outer edge of the wheel, where the water is racing the fastest, will be left completely clear.

In 1867 Cuthbert Collingwood traversed the Sargasso and reported in the *Intelligent Observer* (A Review of Natural History, Microscopic Research and Recreative Science) that the Sargasso Sea, dependent as it is upon oceanic phe-

nomena, changes its position, extent and volume, according to seasons, storms and winds; but its mean position remains the same as it has always been since it was first discovered by Columbus.

In spite of these statements by trained observers, the true facts of the Sargasso were generally withheld. Even the text-books of the late 1860's, such as Professor D. F. Amsted's "Physical Geography," continued to say that the brown weeds of the Sargasso Sea were so thickly matted that they hid the water, and that trees and other land plants were carried out to the sea within the sea.

From the deck of one of the first ships chartered primarily for a thorough scientific study of oceanic life, *H. M. S. Challenger,* Sir Wyville Thomson, the biological observer, saw no dense masses of weed in the Sargasso, merely single layers of feathery strands, floating free of each other. In his long report, "The Atlantic," that appeared in 1878, he said, too, that the *Challenger's* depth-determining devices indicated between 2,000 and 3,000 fathoms over the extent of the Sargasso Sea. No wonder Columbus's plummet-lines could find no bottom.

Those tremendous depths of over two miles in the Sargasso Sea were rediscovered by the oceanographers aboard the exploring ships of the Prince of Monaco. His Royal Highness, with ample funds from his famous casino, could well afford to indulge in his favorite hobby, the study of the natural history of oceanic life. He sent scientists, the world's greatest, France's Professor E. L. Bouvier among them, scurrying far afield to collect specimens and interesting facts for his private Monaco Oceanographic Museum in his own principality. The professors were just as eager as the Prince to gather a scientific harvest from the sea, and they made a good job of it. They searched the ocean's surface and its depths; they collected plants and animals; they neatly preserved, labeled and catalogued them. They plumbed the ocean floor with leaded lines, and they discovered no graveyard of ships in the Sargasso but fine oozy mud at depths down to 11,364 feet.

The scientific reports of Sir Thomson and the Prince of Monaco did not appeal to news commentators, apparently, for the *Chambers Journal* of "Popular Literature, Science and Art" issued the following account of the Sargasso in May, 1897.

> It is only natural that ships should carefully avoid this marine rubbish-heap where the Atlantic shoots its refuse. It seems doubtful whether a sailing vessel would be able to cut her way into the thick network of weeds even with a strong wind behind her.
>
> With regard to a steamer, no prudent skipper is ever likely to make the attempt, for it certainly will not be long before the tangling weeds would altogether choke up his screw and render it useless.
>
> The most energetic explorer of land or sea will find himself baffled with regard to the Sargasso Sea by the fact that it is neither one nor the other.

In their journal the imaginative William and Robert Chambers said that the Sargasso held "keels or skeletons of ruined ships, so covered with barnacles, shells and weeds that the original outline is entirely lost to view; and here and there a derelict ship, transformed from a floating terror of the deep into a mystery out of reach of men in a museum of unexplained enigmas."

With Chambers's easily available and seemingly reputable essay before them, the story-tellers got busy. Finding that Jules Verne's versatile mind had not yet invaded the Sargasso Sea, other pseudo-scientific writers took possession, unleashed their own inventive powers and created a fantastic floating world of their own.

Thomas Janvier, America's Jules Verne, utilized this gruesome locale in 1898 for his hair-raising novel, "Sargasso Sea." His young hero, Roger Stetworth, hearing of a job in the Indies, innocently takes passage on a ship which turns out to be a slave-runner.

He is robbed and beaten by ship's cutthroats and then thrown overboard. Roger manages to cling to a floating mast on the outermost fringe of the Sargasso. He drifts to the heart of the Sargasso Sea. Let him tell you what he saw:

> Far away, under the red mist, across the red gleaming weed and against a sunset sky bloody red, I seemed to see a vast ruinous congregation of wrecks so far extending that it was as though all the wrecked ships in the world were lying huddled together there in a miserably desolate company.

Roger explores his fantastic world, finding dead men at their gun-posts on abandoned war vessels, seeing skeletons of slaves with their arm and leg bones encircled by iron shackles, and eye-witnessing two ghost-like men murder each other.

Roger eventually finds a small steam launch which he fixes for his escape from the Sargasso Sea. To students of oceanic phenomena, this incredible trip is the most startling part of the remarkable story. The tangle of weed, he says, is so heavy and solidly grown together that he is obliged to open a channel for his boat. First starting his engine, he rushes forward, and, taking a stand far over the bow, he begins the laborious task of cutting the thick vegetation with a hand saw.

"I had to stand like a machine there" he wrote—"endlessly hauling the saw up and endlessly thrusting it down. Behind me, my little engine plugged and snorted; over the bows below me, was the soft crunching sound of the weeds opening as the boat thrust her nose into it, and on each side of me was the soft hissing, rustling of the weeds against the boat's sides."

After a month of disheartening toil, traveling at the rate of three miles a day, Roger finally reaches open water, a passing ship and safety.

The same year, as if to refute the picture of horror that Janvier had drawn, Frank T. Bullen, first mate on an American whaler, described his pleasant experiences in the Sargasso in his famous book, the "Cruise of the 'Cachalot.'"

When eight days out of New Bedford, Massachusetts, Bullen says, they were within range of the Sargasso Sea. "It fell a dead calm, and the harpooners amused themselves by dredging up great masses of the weed, and turning out the many strange creatures abiding therein. What a wonderful life the weed is, to be sure!" Not only Bullen but others who were intent upon learning the truth of the Sargasso Sea were amazed at the strangeness of the animal life of the region.[1] Parkinson in "Amid the Islets of Sargasso Sea" described for readers of *Living Age* the beautiful phosphorescence of the weeds at night, eery lights that were created by millions of tiny sea organisms clinging to the floating weeds. Similarly, Charles F. Holder, foremost teller of tales of big game fishes, described the Sargasso as a veritable garden "traversed by a maze of mimic rivers as rich and deep in cobalt as the Florida sky above it." Far from being a region of desolation and horror, the Sargasso Sea was a place of vibrant life and serenity.

The campaign of debunking the horrors of the Sargasso continued. Thaddeus Dayton explained the "Mystery of the Sargasso Sea" for readers of *Harper's Weekly* of July 16, 1910. He described how the Norwegian bark *Crown*, wrecked and abandoned, drifted into the Sargasso Sea on one side and came out from the other, apparently passing right through the very center of the so-called city of dead ships. His story was followed by John Stevenson's. This narrative, in *Science*, records two passages through the heart of the Sargasso in 1910. Stevenson failed to see any sign of the reputed pestilential weed city; indeed, for distances of 1,500 feet he saw no weeds at all. And again in 1911 the

[1] For a picture of the strange animals of the Sargasso, see "Animals of the Sargasso Merry-go-round" by Myron Gordon in *Natural History Magazine*, 42: 12–20, 1938.

diligent *Review of Reviews* pointed out to a skeptical public that the records in *Pilot Charts,* covering a period of 23 years and describing the courses followed by 157 derelicts, indicated that the tales of jungle-like weeds in the Sargasso capable of stopping a ship were quite fantastic. These revelations were further confirmed by the reports that came from the *S. S. Michael Sars,* a ship commissioned to study the Sargasso Sea under the expert guidance of Sir John Murray.

The sedate oceanographic records on the Sargasso, as before, failed to reach a large part of the reading public. The cut-and-dried statistics of little-known scientists did not stand out against the dramatics of novel heroes and their exciting adventures. Scientific reports did not stop Justus Miles Forman from writing, *Collier's* from publishing and *Collier's* readers from thoroughly enjoying, in 1911, that tingling story called "Sargasso Sea" in which most of the action takes place in that "dismal sea," "that heaving swamp," "that tract of mystery and death."

The much-maligned Sargasso flashed into prominence again in the early 1920's when Captain A. E. Dingle spun a yarn around Sargasso Sam, a lad found shipwrecked in the "golden, weed-choked, azure sea that fable and superstition have peopled with dead men and filled to congestion with the wrecks and ghosts of dead ships." Readers of the *Saturday Evening Post* for May 5, 1923, will recall with delight Sargasso Sam's physical and mental resurrection.

When William Beebe announced his projected Sargasso Sea expedition, the *New York Times Magazine* of February 15, 1925, headlined it: "THE ARCTURUS WILL EXPLORE SARGASSO SEA IN SEARCH OF LITTLE KNOWN MONSTERS. OFF TO THE FABLED SARGASSO!" This inspired an outburst of editorial and factual comments. *Popular Mechanics* described the ingenious technical gadgets on the *Arcturus. Radio Broadcast* described radio's part in preparing to announce the day-by-day discoveries. Editorials appeared in the *Nation. The Independent* deplored Beebe's expedition, exclaiming wistfully that it would destroy the people's faith in the romantic legends of the Sargasso. It wrote: "How many dull eyes have brightened over the imaginary contemplation of that fleet of stately Spanish galleons drifting forever in the silence, of the skeletal captain in his cabin sitting at his dice and wines, the crew all tattered skeletons, the cargoes of diamonds, emeralds and gold moidores." But when Beebe took his laboratory ship to where the Sargasso Sea was supposed to be, he found no mass of weeds larger than a man's head. That was ironic. While Beebe's radio story of his poor luck was rushing through the air on its way to the *New York Times,* it was picked up by Captain Harry Sumner aboard the freighter, the *Clan MacFayden,* a thousand miles away, but still within the Sargasso. While the *Arcturus* was anxiously searching the sea for weeds, the *Clan MacFayden* was wallowing in "weeds so dense that with full steam ahead the large freighter seemed to be held back."

The explanation for this seemingly contradictory evidence is that a rare and violent storm had hit the Sargasso during the early spring of 1925 and apparently had scattered patches of Sargassum in some regions and piled them together in others.

So again in modern times, in the present period of the twentieth century, some sailors confirm and others deny Oviedo's sixteenth century story that the *Sargaço,* a sea of little grapes, is a *praderias de yerva,* a weedy prairie, so thick that it is capable of slowing the progress of a vessel. And it is probable that as long as men sail the seas and men write stories, the cycle of tales concerning the Sargasso will go round and round like the course of the weedy sea itself.

AN INTERESTING BOOK

By W. L. McATEE

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THE copy before me has the appearance appropriate to an interesting book of a certain degree of antiquity. Some of its pages are loose and worn; its back is broken; it has been scarred by service. It has passed through many hands and has been annotated by some of them. The notes but add to the interest of the volume.

The book is entitled, "The Market Assistant" and it was published at New York City in 1867 (455 pp.). Devoted to "what we eat," it is not, however, restricted in scope, but records anything and everything of interest connected with food. The quaint, the ordinary, the veritable and the speculative, all find place in its pages; it informs, surprises, pleases. Would you learn about market grafting and lying, or the origin of porterhouse steaks, the dangers of grand dinners or the introduction of potatoes to England, the carving of human dentures from cattle teeth, or the beginnings of fish culture, the author is your guide. He makes a point of naming individuals connected with "curious incidents and anecdotes," thus furnishing a happy hunting ground for the genealogically inclined. Sample entries are:

Adams, John Q., presented with a large Codfish,

Astor, John Jacob, presents the skin of a "white wild sheep,"

Beebe, Theophilius, assists to take a monster Vampyre of the ocean,

Braisted, G., takes a Spotted Gunnel out of an oyster,

Cadwallader, General, of Philadelphia, dines on a large Brook Trout,

Cooper, Peter, purchases cattle feet for making glue,

Dwight, Dr. Timothy, on the Horse Mackerel,

Greeley, Horace, on the flesh of the Prong Horn.

Others there are by the score. The conclusion may be that the author could have been the gossip columnist of his day. If that implication is an unpleasant one, the reviewer feels that it is unjustified, for our author deals only with subjects that are legitimate objects of human curiosity.

A previous work, "The Market-Book," by following the same custom of recording names, drew the fire of "An Indignant Gentleman" who objected to his ancestors being recorded as butchers. "If my grandfather chose the trade of butcher, why should I be blamed for it? . . . All that I can do is to denounce the author . . . as a reckless disturber of family pride. In behalf of many proud and wealthy families of New York, I [so] denounce him." The author, Thomas Farrington De Voe, did not share the views of this correspondent, for at the end of the preface he signs himself "Butcher." Evidently there are butchers and butchers and De Voe, by his works, stands forth also as a scholar, a historian and an artist. The well-executed frontispiece of "The Market Assistant" vouches for the third of these specifications, both of his books for the second, and his thorough gathering of their materials for the first. As a particular point of scholarliness, book users will appreciate the 20-page classified index. It was made to help them and it serves. The section called "general index" leads to all the "curious incidents and anecdotes" and shows that the author knew them to be a feature of his work that would be appreciated. Within proper limits of a review, their diversity can be no more than indicated. They deal much with large things or accom-

plishments. There is, for instance, record of an oyster measuring $37 \times 23\frac{1}{2}$ inches, of a sturgeon weighing 354 pounds and of a leather turtle of 800 pounds. The "largest woodcock found on record" (1 pound, 1 ounce) shot in Washington Township, New Jersey, in 1859, could only have been a specimen of the European woodcock, a species that has been collected only a few times in North America.

Among the anecdotes are such certainly unusual items as the catching of three fishes on one hook and the killing of three otters at a single shot. There is an account of a side hunt for woodchucks in Massachusetts in 1820 in which 1,154 of the animals were destroyed by one party and 873 by the other. The vegetable kingdom is not ignored, witness records of the production of 1,528 pounds of pumpkins from two seeds, and a season's yield of 108 gallons of sap, making 33 pounds of sugar, by a single maple tree.

Among curious notes are those relating to a two-headed terrapin and to a sea-serpent of the early 1800's which, upon capture, proved to be a horse-mackerel or tunny. De Voe records an alligator that was killed near Bushwick Ferry, Long Island, in 1815. As at that early date, transport of the animal from the South was unlikely, this occurrence may be proof of extended natural wandering by this animal which appears to be almost as much at home in salt, as in fresh, water. The author contributes one of the comparatively few accounts of the flesh of grouse becoming poisonous from the birds having fed on "green laurel."[1]

Our author has preserved one of the few actual records of eagles setting their talons so firmly in a large fish as to be unable to withdraw them and thus risk being carried under the water and drowned. The fish in this case was a 33-pound striped bass, but the eagle was rescued alive. However, both eagles and ospreys have met their fate in this way and so doing, in at least one case, founded an Indian legend. A hunter on a clear lake saw passing beneath his canoe a large muskellunge upon which was riding an eagle, seemingly flying through the water. This apparition, involving creatures of such mighty import in the religion of the tribe, struck terror to the Indian's heart, brave warrior though he was. Rushing back to camp he told the tale and in time it became part of the mythology of his people.

Thus far reference has been made to only a few of the more beguiling passages of "The Market Assistant." The greatest value of the work, of course, lies in its serious portrayal of marketing conditions and in its listing and discussing the great variety of foods that came to the markets in the period 1832–1867. These include not only the domesticated animals and the cultivated fruits and vegetables, but also game, fish, shell-fish, pot-herbs, medicinal and other plants, and nuts. Some of the chapters are small books in themselves, as that on domestic animals, 84, wild animals called game, 83, and fishes, 120 pages, respectively. In the section on fruits there is information of historical value on the varieties in favor at that time and on their origin or introduction. The work is a mine of information also on vernacular names for all the groups considered.

Treating of the sources and abundance of animals on the market, the book is treasure-trove for the student of the depletion of American wildlife. Relating to the group—birds—in which the reviewer is most interested, De Voe comments upon three species now certainly, and a fourth that is probably, extinct. It seems a marvel that this man with whom, through his book, one almost feels well

[1] This subject is discussed at some length in the Proceedings and Transactions of the Nova Scotian Institute of Natural Sciences, Volume 6, 1886, pp. 78–84.

acquainted, should have actually handled birds that are now gone forever. He did not realize that any of them were disappearing. He thought that the heath-hen, which he records as vanished from Long Island and scarce in Pennsylvania, was the same species as the still abundant mid-western prairie chicken. The passenger pigeon was then being brought to the markets in thousands and the author had "often enjoyed the sport of taking the wild pigeon," which he describes. He lists the Labrador duck under the three vernacular names of skunk duck, sand shoal duck and pied duck and terms it a scarce species, seen only in the months of March and October. Those dates would indicate migration of this duck to the southward of New York and are more than is on record elsewhere on the subject. It is a remarkable thing that most extant specimens of the Labrador duck were obtained at markets. Thus in all probability some of the market gunners knew more about the bird than all ornithologists together have known. De Voe wrote as if the species were maintaining its status in 1867, but the last known specimen was collected in 1878. For the Eskimo curlew, the extinction of which few now doubt, our author had no fears. He terms it from the gastronomic point of view as "the best of all the curlews."

Those who have known markets only in recent times, and particularly since passage of the migratory bird treaty act in 1918 which stopped practically all sale of wild birds, can hardly realize the extent to which birds were previously marketed. De Voe in a section on wild fowl includes 33 kinds of ducks, geese and swans besides a grebe and the loon. In another division headed, "Birds Called Game," he treats of 9 native and 4 British birds of the grouse and partridge group, of the European and American woodcocks, 30 native shore birds, 5 species of the coot and rail alliance, 1 tern, 4 herons, the wild pigeon and turtle dove, 2 eagles and 29 small birds, which we almost forget ever had the status of game.

Items of special interest relative to many of these birds reward the attentive reader. As to the trumpeter swan, of which he unmistakably describes "the very lengthy windpipe encased in the breast-bone," he says what probably no living ornithologist would have suspected, namely, that, "this species is not so scarce in our markets as the whistling swan." The latter species under protection has maintained its numbers while the trumpeter is now restricted to small colonies in Montana, Wyoming and British Columbia.

The canvas-back duck apparently gained its high market standing in De Voe's time. He says, "Until very lately, the gunners used to confound these birds with broad-bills, red-heads, and other ducks, and sell them all together. There was no difference in the price. Twenty-five cents would purchase a canvas-back as readily as an ordinary duck. But now . . . the price of a pair of these birds has risen to two and three dollars."

Our author incidentally reveals something of the extent of the traffic in wild fowl in recording that a substantial citizen of Back Bay, Va., employed 20 men to shoot for him and shipped weekly to the New York market an average of from 15 to 25 barrels of ducks and geese.

De Voe's casual remark about avocets, "A few also are found here, brought from Long Island," should stir the curiosity of present-day students, as these birds have only rarely been seen on the Atlantic Coast for many years.

The small "birds called game" listed in this market compendium include some that most of us have heard about in that connection, as the nighthawk, flicker, robin, meadowlark, reed-bird or bobolink, and blackbirds. The group comprises a number of other kinds, however,

now utterly foreign to our conception of food birds, as the purple finch, seaside finch, cedar bird, catbird, brown thrasher, hermit thrush, Baltimore oriole, blue jay, red-headed woodpecker, cockoos and kingfisher. De Voe even mentions kingfisher and flicker squabs being brought to market.

It must be recorded, to his credit, that our author, though a butcher, did not approve of all this traffic in small birds. Of robins he says, "I . . . think that these birds are more useful to man living than dead." Again of the brown thrasher, he remarks, "Its flesh is delicate, what there is of it; but its live body is *larger* to the farmer, who ought to protect it." Cedar birds, he says, "should never be killed as they destroy more destructive worms than perhaps any bird in existence. In fact all such worm-destroyers should not only be protected by a stringent law, but every person should be so instructed that no law would be required for their protection."

De Voe here grasps the modern philosophy of simultaneous conservation and education. His views on bird protection are further elaborated in the following passage, notably advanced for the time.

> In naming the numerous species of game and other birds . . . I do not wish to encourage the destruction of a single life that would be more useful to the economy of nature than its dead body for the table. In fact, I would go so far as to wish the passage of a United States general law that would especially protect all birds smaller than the quail, except a few shore-birds, or those which are considered and known to be injurious.
>
> Thousands of birds of the small species are wantonly killed merely for the sport, or a few pence. These slaughtered birds, when alive, destroy millions of insects, flies, worms, slugs, etc., penetrating every nook and corner of hedge, thicket, or field; bush and tree, they clear limb after limb, while every passing, folded, or withered leaf is carefully examined and deprived of its concealed but destructive tenant. Without these useful and beautiful little "trespassers," the many destructive insects would increase so rapidly as to become almost a plague, by destroying all fruit and vegetation; while the loss of a little fruit or seed for their subsistence for a short period would amply repay the cultivator for the great services they render him.
>
> It has been particularly noticed that they do not often touch the sound fruit when they can find those that have worms in them. From this fact, they should not be driven from the fruit-trees: they are friends and benefactors, not only to the cultivator but to mankind at large, and to all who have a sentiment for all that is beautiful, poetic, and most musical of nature's productions.

Thomas De Voe's was an early voice urging the value of birds and their national protection. He may with honest pride have called himself Butcher but certainly he had not the soul of a butcher.

THE RISE OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

By T. SWANN HARDING

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THE organic act founding the Department of Agriculture directed it "to acquire and to diffuse among the people of the United States useful information on subjects connected with agriculture in the most general and comprehensive sense of that word." Hence, throughout its history it has collected, discovered and diffused knowledge about agriculture with increasing effectiveness. The gradual changes in its structure have always reflected basic changes in our national agriculture. The department has been required to respond to public needs as the demands of the public caused Congress to enact new agricultural legislation.

Farming in this country was originally more than a subsistence occupation; it was a way of life. The entire being of the farmer and his family was based upon the farm and all the early distinguished characters of our history were farmers. Indeed practically all of our people were on the soil. But as time passed agriculture became a competitive commercial enterprise. This transformation became possible because of advances made by science and technology. It was not until this change was well under way that we needed a Department of Agriculture. Neither our early American colonies nor their mother countries had ministers of agriculture. The head of each farm family was his own secretary of agriculture.

It is a very far cry from the farmer of 1794, who could produce everything he needed by his own efforts, and the farmer of 1940, who may specialize in producing only one or two commercially marketable crops, while he depends even for much of his own food upon manufactured products transported to him through long distances. In 1794, for instance, the famous French gourmand, Brillat-Savarin, visited a Connecticut farmer. He tells in his "Physiology of Taste" how he ate a dinner of superb corned beef, a stewed goose, a magnificent leg of mutton, with vegetables of every description, and two huge jugs of cider at each end of the table. Thereafter the happy farmer addressed him thus:

> You behold in me, my dear sir, a happy man, if there is one on earth; everything you see around you, and what you have seen at my house, is produced on my farm. These stockings have been knitted by my daughters; my shoes and clothes come from my herds; they, with my garden and my farmyard, supply me with plain and substantial food. The greatest praise of our government is that in Connecticut there are thousands of farmers quite as content as myself, and whose doors, like mine, are never locked. Taxes here scarcely amount to anything, and, as long as they are paid, we can sleep calmly. Congress favors in every way our rising industry; agents from every qaurter are always ready to rid us of all that we have to sell; and I have ready-money in hand for a long time, having just sold at $24 the barrel of flour for which I usually get $8. . . . I am master in my own house.

That final note indicates that women's rights had not yet been thought of, also that the farmer was his own secretary of agriculture. It was not until farmers got into a commercial economy and began to produce for trade, not merely for home consumption, that they felt the first faint stirrings of need for governmental aid. By the first decade of the nineteenth century an increasing number of farmers began to attempt the difficult operation of producing for sale.

Several other things happened simultaneously then or soon after. Canals and railroads appeared; the telegraph was invented; the British Corn Laws were repealed—inviting the export of American farm products. Farming became a more difficult and complex operation. New plant and animal diseases and new insect pests appeared. When farmers finally wanted government aid badly enough they got it for, as T. V. Smith has often said, a democracy is that form of government in which the individuals or groups who yell loudest get most out of the government.

There are millions in this country today whose ancestors were colonial stock and whose forefathers, generation after generation, enrolled in the army of voluntary resettlement which shoved the frontier from the Alleghenies to the Pacific in little more than a century. This continental sweep of events inevitably produced the need for the great varieties of public service that only a modern department of agriculture could supply.

Even in early days not all American farmers were as happy as the one Brillat-Savarin visited. Some of them worked like slaves and lived a hard and a dangerous life. If they wanted government aid it was mainly in the form of soldiers to combat the manifest tendency of wild Indians to create premature baldness with a scalping knife. But as William Allen White has noted, these farmers had about the same agricultural equipment as Abraham and Lot when they moved into Ur of the Chaldees—the wheel, the lever and cutting tools—though they also had gunpowder, firearms and books which Abraham did not have.

As early as 1770, Benjamin Franklin, then agent for Pennsylvania in Europe, began to send home plants and seeds to be tried out here. Jefferson, our first Secretary of State, was interested also in foreign plant and seed introduction and enlisted the services of our consular staff to that end. Before that, in 1773, John Adams had introduced resolutions in the Continental Congress proposing that the government encourage the production of certain farm commodities and advocating the establishment of an agricultural society in each colony.

In 1793 the famous Scottish financier and agriculturalist, Sir John Sinclair, founded the first Board of Agriculture in Great Britain. George Washington corresponded with Sir John and in a letter written in 1795 expressed the hope that a national agricultural society would soon be formed here. In his last message to Congress, delivered December 7, 1796, Washington declared that the cultivation of the soil was a proper object of public patronage saying also: "Institutions for promoting it grow up supported by the public purse, and to what object can it be dedicated with greater propriety?"

But no action was taken. American agriculture was still primitive. Farmers worked along with their wood-toothed harrows, their wooden plows with iron points, their hoes, spades, sickles, flails, and little else. Until the age of advancing agricultural technology dawned and got well under way between 1830 and 1850, they felt little need either for elaborate tools or government aid. The more daring of them simply moved on to the ever-progressing frontier as the land wore out where they were.

But some farmers had to remain where they were. Naturally they felt the competition from the rich new lands of the West. For those who went to the new frontier could now produce and ship cheaply back East. Hence the farmers left in the settled eastern rim of the country began to think in terms of government aid to agriculture.

Agricultural societies began to be formed as early as 1785 and by 1831 there were 800 farmers' clubs. Agricultural fairs and expositions became increasingly frequent. The first American

agricultural journal appeared in 1819 and by 1860 there were 40 farm publications. Agricultural education grew from a single chair at Columbia in 1792 to 5 agricultural colleges that sprang up between 1854 and 1860. The federal patent law had been enacted in 1784. Nearly all patents granted in early days concerned agriculture and by 1837 to 1839 the Commissioners of Patents were concerned about the onward march of agricultural technology and how to cope with it.

The American Congress early formed agricultural committees, subsidized silk growing, the culture of sugarcane and the publication of certain agricultural treatises. The Patent Office, then in the Department of State, began in the 1830's quite regularly to collect and distribute new plants and seeds. The first Commissioner of Patents resident in Washington, then a city in the woods, arranged for an agricultural fair which was held in the mall near the present Department building; that was in April, 1805. The first agricultural exposition in the country was held at Union Hotel, Georgetown, in May, 1810; President Madison attended.

The Commissioners of Patents continued to stress the urgency of their needs; they must have aid to cope with demands made upon them by farmers. Meanwhile, on July 4, 1836, the Patent Office assumed its modern form under a new law signed by President Jackson, and its commissioner's first printed report appeared in 1837. Finally, in 1838, President Van Buren, in recommending that the scope of the Sixth Census be increased, induced Congress to grant the Patent Office the legal right to use $1,000 of its incoming patent fees to collect agricultural statistics and for other agricultural purposes. That money became available in 1839. Agriculture thus got its first aid from the Federal Government.

In 1849 the Department of the Interior was created and the Patent Office formed part of it, its Section of Agriculture going along. Responding to public demand, President Taylor in 1849 and President Fillmore in 1851 recommended that Congress create government machinery to promote agriculture. From 1830 on the agricultural societies persistently hammered away at this idea until at long last they got what they wanted.

For some time the turmoil over slavery obscured their needs. Furthermore, the Southern delegation to Congress very sincerely believed in the doctrine of states' rights and did not think that the government should aid agriculture. President Buchanan in fact vetoed the first land-grant college act not only because he thought it extravagant but also because he thought the Federal Government lacked constitutional right to provide the aid for the states contemplated by the act—specifically he held that the central government could not give public lands to state governments.

But the need for the department increased as technology advanced, transportation facilities improved, new plant and animal diseases and insect pests appeared, and commercial farming progressed. Finally came the Civil War. The manpower went to the front. It became urgently necessary to produce large quantities of food in the most efficient manner possible. Moreover the Southern delegation no longer sat in Congress. Economic problems further intensified as agriculture became a business, a competitive enterprise. The farmer now formed part of a money economy; he had embarked on the stream of commerce. He must have government sources of information as did the businessmen with whom he had dealings. The government had long given manufacturers and businessmen aid and protection—why not farmers?

Farmers now produced commodities that went floating down canals or spin-

ning away on rails to consumers they never saw. Away went the farmer's stark individualism and his independence of governmental aid. New means of transportation brought western products readily into what had been regarded as exclusive eastern markets. Voluntary efforts of farmers' institutes and societies to teach skill in production methods proved insufficient. The clamor for Federal Government aid was irresistible.

Evidence of this appears in the annual reports of the Commissioners of Patents. In his report for 1861, Commissioner D. P. Holloway made a prolonged plea for the establishment of some institution to serve agriculture. For many years now the Patent Office reports had been devoted predominantly to agricultural matters. Three fourths of our citizens were still on the land, and their pleas could no longer go unheeded.

Why, asked the commissioner, was poor land worth $100 an acre in New Jersey whereas rich land in Kansas was worth nothing? It was because farmers in New Jersey had customers close by. Agriculture must be aided by industry. Our soil, already far wasted in the East, must be preserved and enriched. Worthless breeds of cattle must be replaced by good cattle. Agricultural tools and implements must be still further improved and rendered more widely available. Hence we should have a Federal Government agency with three bureaus, agricultural, mechanical and commercial.

In his message to Congress of December 2, 1861, President Lincoln sandwiched in an almost offhand recommendation that we might well have in the Federal Government an agricultural and statistical bureau. Naturally more pressing issues tended to occupy his energy at the time, but Congress took heed. It in fact passed three important agricultural laws all of which were duly signed by President Lincoln.

The first signed May 15, 1862, established a United States Department of Agriculture with bureau status, broadly defined its functions, and placed a commissioner at its head. The second, signed May 20, provided for apportioning freehold farms of 160 acres each from the public domain to citizens who would make their homes on the land and till it for 5 years. The third, signed July 2, endowed the so-called land-grant colleges with 11,000,000 acres of public land, an area roughly equal to that of Vermont.

The first commissioner of agriculture had previously been in charge of agricultural affairs in the Patent Office. He was a successful farmer and farm manager with the distinguished name of Isaac Newton. In his first report to the President he stressed the necessity for performing scientific experiments to obtain new agricultural knowledge, and for the immediate publication of this information when obtained. The department spent a little less than $35,000 in the first 6 months of its existence, and much of that went for seed distribution.

Newton said peace must come before agriculture could prosper. Thereafter we should seek an increasing foreign and domestic market for agricultural products; we should have greater respect for labor, a more thorough knowledge of agriculture as an art and as a science, and a more thorough education of our farmers in science and political economy. Whereas farmers had been accustomed to till primitive soils and then move on to new acreages when the soil was exhausted, they must now learn how to make two blades of grass grow where one had grown before.

Above all agriculture must rely on science, "The what and how to do—the concentrated experience of the ages." Applied chemistry would aid us to unveil the mysteries of plants and soils. Nothing was impossible to labor aided by science. Specifically Commissioner Newton said his department would collect,

arrange and publish useful agricultural knowledge; it would collect and introduce valuable plants, animals and seeds; it would answer the inquiries of farmers and be guided by them in its choice of subject-matter for publication; it would test by experiment the use and value of agricultural implements, seeds, soils, animals and fertilizers, undertaking appropriate chemical studies; it would promote botany and chemistry and establish a library and a museum.

Many of these things were done quickly as we shall see later. In his report for 1863 we find Commissioner Newton complaining that the half dozen rooms assigned to his department in the Patent Office basement were much too confining. He also desired better facilities for experimentation with plants. It was true that Reservation No. 2, between 12th and 14th Streets, S.W., now forming part of the department's grounds, had been assigned to him, but the Army had had to take it over as a cattle yard. Ultimately, Commissioner Newton rented two additional rooms in an office building near his own office, and he also got control of Reservation No. 2 which, however, proved inadequate before his death.

For Commissioner Newton died in line of duty June 19, 1867, as a result of sunstroke suffered in July, 1866. He had heard a thunderstorm approaching and had left his office hurriedly to get to a part of the experimental plot a mile away in time to save certain wheat samples from a drenching. While standing in the hot sun supervising this work he suffered sunstroke. The Commissioner was correctly attired in a high silk hat at the time. Washington summer sunshine did the rest.

Horace Capron followed Newton as commissioner and we find him reporting to President U. S. Grant in 1870 on the manner in which he had expended his annual appropriation of $169,175.24. In this report we find the following interesting paragraph which showed that mere untrained time servers could not do the work of the Department of Agriculture even in 1870.

> The department's work demands a higher order of talent than the routine service of most public business; it requires a knowledge of national economy, social science, natural history, applied chemistry, animal and vegetable physiology and practical agriculture; and presents so broad a range of facts in each field of investigation as to demand the most active effort and the most persistent industry. For such labor the most meager compensation is offered, and it is found difficult to obtain an increase of suitable service, and impossible to remunerate properly that already employed which is found to be most efficient and reliable, while that which is practically useless for the purpose is offered in unlimited measure.

Commissioner Capron then asked increased compensation for his employees as did also Commissioner Wm. G. Le Duc 10 years later. It may be said in general that the heads of the Department of Agriculture now resigned, have all been inclined to speak highly of the qualifications and diligence of the employees.

In his report for 1880, Commissioner Le Duc said that the division of chemistry was "now confined to a room in the present building, 20 feet square, with two basement rooms of the same size and a small closet." Hence much important work could not be done. He thought this "national laboratory of a great people" should have better support. The staff then consisted of the chemist and 11 assistants. At that time the Commissioner of Agriculture got $3,500 a year; the chief clerk, chemist, statistician, entomologist and superintendent of the grounds got $2,000 each, and the botanist, microscopist, disbursing clerk and superintendent of seed distribution got $1,800 each.

Farm clamor continued for the department to be raised to full cabinet rank. This reached full intensity just about the time the last of the good public land had been given away and the agricultural frontier was gone. Largely because of

efforts made by the National Grange a bill was passed to the desired effect and on February 9, 1889, Commissioner Norman J. Colman became Secretary of Agriculture. He held this office for 26 days, for the administration changed and Secretary Jeremiah M. Rusk assumed office March 7, 1889. He was the first Secretary of Agriculture by appointment and his first report was dated October 26, 1889. He said the building was very crowded, and then went on:

> I found clerks crowded into rooms and subject to discomforts and inconvenience. I have found two branches of two distinct divisions crowded into one small room; records and books lying about upon tables and chairs for want of sufficient wall space to accommodate cases for their proper care and preservation; the chemical laboratory crowded into a damp, illy ventilated and wholly unsuitable basement, originally intended no doubt for storage purposes, and its work in certain investigations restricted because of the offensive fumes from such analyses, and because of the dangers to human life and limb from explosions of gases and other causes; and, in a word, there was a complete want of that systematic and orderly conduct of public business which ought to obtain in every well-conducted office.

At that time not only Great Britain, Germany, France and Russia, but even Brazil devoted far more money to public agricultural services than did the United States. Even then the department received nearly 40,000 letters of inquiry yearly "from all sections of the country, from all classes and conditions." Some thirty million people then depended for their livelihood directly or indirectly upon agriculture. "The correlation of agriculture with other industries of this country" must be carried out, said Secretary Rusk, for the productivity, wealth and prosperity of the farmers governed that of the nation as a whole. Secretary Rusk also began to publish Farmers' Bulletins and started a Division of Publications and the giving of agricultural items to the press. He wrote:

> Time and expense, ability and experience, lavished on the work of this department can have no practical results unless we can lay their conclusions promptly before the people who need them.

The department now really became an educational institution. When it assumed cabinet rank the department consisted of the following units:

> Division of Statistics; Division of Entomolgy; Division of Chemistry; Section of Silk Culture; Division of Botany; Section of Vegetable Pathology; Division of Economic Ornithology and Mammalogy; Division of Microscopy; Office of Experiment Stations; Division of Forestry; Division of Gardens, Grounds and Horticulture; Seed Division; Division of Pomology; Folding Room; Library; Museum; and the fully fledged Bureau of Animal Industry created by Congress in 1884. (The Weather Bureau became part of the Department of Agriculture by transfer from the War Department in 1891.)

Meanwhile the continent had been pretty well settled. The era of the open frontier ended formally with the annual report of the Commissioner of Lands for 1890. This closing of the frontier was very significant in determining the growth of public demands for government aid based upon accurate scientific agricultural knowledge. The farmer now had to grit his teeth when the going got tough where he was and make the best of the farming business there. He could no longer move on to rich frontier lands.

Specifically that meant watching carefully the cost of producing each bushel, or pound, or bale of farm products to keep his net return as high as possible. Hence it took reliable scientific information to determine how to reduce the unit cost of production while increasing the net return. This required knowledge about plant and animal diseases and destroying insects, about new and better breeds, varieties and cultural methods.

That knowledge, when applied, acted like ready cash. For it directly increased the per-hour reward of labor by the farmer and his family. Hence it was natural that just around 1890, when the frontier closed, the people should promote their Department of Agriculture to

cabinet rank, increase the appropriations of the department and federal aid to the state agricultural experiment stations as well (as in 1887), and authorize a federal grant of money to the state land-grant colleges, as was done in 1890. By 1896, the Department of Agriculture had 2,497 employees and all were in the classified Civil Service except the Secretary, his private secretary, the Assistant Secretary and the Chief of the Weather Bureau. Its annual appropriation was then $7,305,637.

We should now look for a moment at the development of the department's individual functions and the growth of its respective units. The first professional employee appointed by the department was a chemist, Charles M. Wetherill; that was in 1862. The department's first scientific research publication was his "Report of the Chemical Analysis of Grapes," which appeared also in 1862. In the seventy-five years that elapsed between 1862 and 1937 there were issued by the department's chemists and soil scientists 8,428 scientific and research reports.

The services of a botanist and a statistician had been required by the agricultural service while in the Patent Office, but Lewis Bollman, statistician, and Townend Glover, entomologist, of the department, were appointed by Commissioner Newton in 1863. A specialist in forestry appeared in 1877, and a Veterinary Division, by special Congressional appropriation of $10,000 in 1879. A microscopist was appointed in 1871, a special agent to study public roads in 1893, and other specialists as new problems required study.

What later became the Biological Survey got its start as a section of economic ornithology in the Division of Entomology in 1885. In 1893 Congress appropriated $10,000 for a study of human nutrition and that began in the Office of Experiment Stations. The specific soils work of the department had its origin in the Weather Bureau in 1893 also. The Bureaus of Chemistry, Soils, Forestry and Plant Industry were created in 1901 and the Bureau of Entomology in 1904. A Bureau of Statistics was created in 1903; 20 years later the Bureau of Agricultural Economics was set up.

Cattle diseases caused increasing concern after the Civil War, contagious pleuropneumonia and what later came to be known as cattle tick fever in particular. There was increasing agitation for Federal aid as the individual states proved incapable of stamping out the diseases themselves. It was as a result of this agitation that the bill to create the Bureau of Animal Industry was introduced in Congress. That bureau controlled contagious pleuropneumonia within 5 years at a total cost of little more than cattlemen were losing annually from the disease in decreased shipments to Great Britain alone.

The bureau later solved the cattle tick fever disease and has now all but wiped it out. It entered in upon a long career of research and regulatory work that has been of inestimable value to the American public in cities as well as on farms. On its staff have worked many who became illustrious in research circles.

As an example of the manner in which certain functions had to be assumed by the department consider the food and drug work. Remember initially that the farmer is essentially a commercial producer who sells at wholesale and who buys at retail. Hence he early needed protection in his capacity as a consumer of products and materials that enabled him to function as a producer. The early chemists of the department therefore studied feeds, fertilizers, soils, plant and grain varieties, cereals.

In the report of the Patent Commissioner for 1844 you will find the chemist had analyzed corn meals and dyspeptics were being assured that only those high

in oil content caused them indigestion! In 1849 the patent commissioner said that the science of food preservation should be studied. In 1868 the Commissioner of Agriculture reported that the chemist had analyzed mineral waters and pharmaceutical preparations and in 1873 he analyzed wines and cereals.

In the report for 1878 we find that the department chemist had analyzed cream puffs, coffee and bologna sausage for suspected poisons and tea and coffee substitutes and adulterants. He had also analyzed baking powder, oleomargarine and a tonic called "Boneset." By 1879 the chemist was making a thorough investigation of butter adulterants. In 1880 the Commissioner of Agriculture explained in his report that the department had no legal control over adulterated foods; this was in blanket reply to many who had written in on the subject. The chemist was then analyzing stock feeds, veterinary remedies, a few patent medicines and even a magic metal polish.

The full names and analyses of these products were published as well as the names of their makers. It was slyly intimated that they were neither worth the price asked for them nor capable of living up to their makers' claims. Soon after 1885, when Harvey W. Wiley became chemist of the department, work on food adulteration began in earnest, spices, condiments, beer, wine, ale, butter and lard being studied earliest. The publication of these studies led to consumer demand for protection. As early as 1883 Commissioner George B. Loring had instituted the study of butter and its adulterations in part, as he said, "to protect consumers against fraud."

The rest is modern history. In June, 1906, the first Food and Drug bill became law after a 30-year battle for its enactment. The Bureau of Chemistry was charged with its enforcement. In 1927, in the interests of efficiency, this regulatory work was separated from the bureau's research, and was set up independently as the Food, Drug and Insecticide, later merely Food and Drug Administration. In 1940, the new and much more effective Copeland Food, Drug and Cosmetic Law went into full effect. All these things took place as a result of public demand, acting through Congress.

At no time could any honest student of its activities say that the Department of Agriculture had grown by fiat of the bureaucrat. Instead its work had always been authorized by Congress in each instance because groups of citizens wanted something done about something and demanded that the department undertake the job. The history of the department's growth offers the most complete refutation in government of the idea that publicity from within a governmental institution alone determines its growth. The department has undertaken its varied lines of work as citizens discovered the many things they could not do individually or by voluntary cooperative effort.

Commissioner Newton observed in 1863 that farmers lacked time, means and ability to carry on experimental investigations in agriculture, and that isolated individuals could not collect and arrange stores of knowledge for practical use. Hence the department was needed to carry on scientific investigations and its scientific workers wrote glowing chapters in the history of research. They well discharged the trust our people placed in their ability to obtain knowledge that would keep open the doors of the common man's opportunity in agriculture. Much of this knowledge also proved of enormous indirect value in fields remote from agriculture. But in time the collection, discovery and diffusion of knowledge proved insufficient.

First, there was need for some more effective method of diffusion than mere publication. The farmer had to have that ready-cash knowledge quickly to cut costs of production. So about 1900 Dr.

Seaman A. Knapp began to develop his "demonstration-farm" idea, working then in the Bureau of Plant Industry. The plan was to operate farms in different localities where only approved agricultural practices were used. Then all in that locality could come, see the demonstration, and go and do likewise. Meantime the boll weevil had invaded Texas and, at great mass meetings, the Texans began to beseech the Federal Government for aid in routing it. One of the most effective forms this aid took was an extension of Dr. Knapp's idea until literally hundreds of demonstration farms had been established and a new system of adult agricultural education had appeared.

Such importance did this novel idea assume that the General Education Board took notice, regarding it as a signal advance in adult educational methods. The board aided financially, ultimately giving over $600,000 a year for a while to extend the method in the North and West. The idea changed somewhat after a while. Highly qualified teachers, extension workers, county agents, home demonstration agents, were sent out to instruct the farmers on their farms. The knowledge produced by scientists was thus implemented and found its place in farming and homemaking practice. By enacting the Smith-Lever Bill in 1914 the Congress formally organized this work and the Cooperative Federal-State Extension Services came into existence.

But, as time passed, even that was insufficient. First, our foreign trade dropped off. We were no longer the bread basket and Europe the workshop. From a peak of farm exports in 1898 there was rather a sharp decline until the start of the first World War. The social sciences had to be brought to the aid of the farmer. His marketing and credit problems required study. In the end methods had to be devised to make it profitable for individual farmers to adopt approved agricultural practices while at the same time planning production to meet demand and conserving the soil and the water supply.

During the first World War and thereafter the position of agriculture became increasingly precarious economically. Vast expansion in acreage cultivated, accompanied by speculative land values, high prices for agricultural commodities, advancing agricultural technology releasing 35 million acres formerly used to feed horses and mules—these factors tended to produce a crisis when our foreign market was suddenly closed soon after the war. At the end of the decade of the twenties, no longer able to sustain our false position as both a creditor and a debtor nation, we shut down on loans to Europe and the inevitable crash followed.

By this time there were essentially four kinds of farmers and all of them had to be considered in attempting to arrive at any solution for the so-called agricultural problem. We had (1) bare subsistence farmers or part-time farmers who just managed to scratch a living out of the soil under the best of conditions; (2) farmers who raised diversified crops and made a fair living because operating scientifically on relatively good soil; (3) highly specialized commercial producers of specific agricultural commodities, the farm factories, and (4) speculators in land and in agricultural commodities.

Agriculturalists now demanded government aid for their industry which was hit harder than any other by the post-war perplexities and uncertainties. The war had reversed the flow of credit. In less than five years Europe owed us huge sums of money which it could only repay by exporting to us. But we shoved up our tariff walls, making this impossible. For a time our loans to Europe sustained the market. But that had to end, then a wave of acute nationalism swept the en-

tire world, we faced increased competition in the foreign market from other sources, and our agricultural export trade declined.

Our century-long trend of producing for an ever-growing export trade thus abruptly ended. But war-time prices had been abnormally high. There had been quick, drastic shifts in land use. Grazing land had been put into cultivation; marginal land had been plowed; forest land had been overgrazed. Grass had been turned under for wheat to win the war. Cash crops had tended to replace grass and forage crops. Soil-binding was forgotten. Agricultural technology increased by leaps and bounds and huge farm factories appeared. Farms sold or were mortgaged for two or three times their former prices and lending agencies made unwise loans to sustain the speculative orgy.

Farmers did their best to make adjustments in the post-war years, but the problem was too big for them. They could not adjust rapidly enough to save their equities. They felt forced to overcrop their land and produce more in the vain effort to meet fixed charges and support their families. Thousands passed annually from owner to tenant status. Millions cried for government aid in readjustment. Others applied directly for relief. The sins of past years rose to haunt us—improper land use, destruction of the soil, water and forest resources, and the exploitation of the forever irreplaceable riches with which nature had endowed us.

All these troubles crashed down upon the farmer. Initially, in the 1920's, farm organizations sought to have a two-price system established that would in part compensate them for the lost foreign market. The Congress passed such legislation, but President Coolidge vetoed it. Later the Congress passed and President Hoover approved legislation setting up the Farm Board to promote cooperative marketing and stabilize prices. But it failed to stem the tide in part because of the international supply-and-demand situation and in part because it lacked effective control over agricultural production.

The rush of laws beginning in 1933, of which that establishing the Agricultural Adjustment Administration was the first, represented Congressional response to public pressure for solution of these many farm problems mentioned above. The laws aimed to promote soil conservation, water conservation, planned agricultural production, reforestation and the rehabilitation of the underprivileged rural population by education in approved agricultural techniques.

Other laws passed related to the public acquisition and development of land submarginal for agriculture, crop insurance, marketing agreements, tenancy reform, the carrying on of basic research to find new uses for crops subject to periodic surpluses and the increase of farm, forest and water facilities. These new programs were conceived on a basis of broad objectives. They depend primarily and continuously upon scientific research and the widespread diffusion of agricultural information. New agencies had to be established to carry out the wishes of Congress—the Agricultural Adjustment Administration, the Soil Conservation Service, the Farm Security Administration, the Farm Credit Administration, the Rural Electrification Administration, and so on.

All this indicates a broad attack upon the problems confronting the agricultural industry as a whole. The American people are simply seeking to integrate agriculture into the modern commercial economy and to put scientific knowledge to work quickly and efficiently. These functions have been entrusted to the department by the Congress. As one part of its job of carrying out the mandates of Congress, the department has set up one

of the most complete planning programs existing in any government in the world and those plans are based directly on science.

But this is not planning evolved above and enforced below. It is democratic planning. Mere good will among administrators and the provision of legal power and appropriations can not put the adjustment processes to work on individual farms. These farms are owned in fee simple and are tilled under contract or by owners. Therefore the owners and users must decide what will be done on their farms. But they must be enabled to make their decisions in the light of all that agricultural science can tell them about such inexonerable factors as soil types, rainfall, degree of soil slope, temperatures and the customs and social habit patterns of the people, locality by locality.

Hence no group of government employees can be wise or competent enough to prescribe exactly how all these public aids to agriculture and the general welfare should be applied. That must in last analysis be settled by the people themselves. But they must act collectively in their communities, counties and states. Hence a natural outcome, in terms of the departmental and other governmental machinery, is the experiment in agricultural planning set up a year or so ago and now swinging into action.

In operating this system the farm people, with technical aid from especially qualified public servants, recommend the application of such public assistance from local, state and federal governments as they feel needed. These recommendations will be brought together state by state and, finally, in so far as they call for federal help, will be considered regionally and nationally. This is essential in a democracy. It is planning from the bottom up and the top down in which all the people have a hand and a say.

This development is natural and inevitable in the operation of a national agricultural policy governing the activities of the department, since the department itself, in all its varied lines of work, represents merely the democratic response of government to the needs of farmers and of the general population. Hence, you will find a definite continuity in policy of the department, and of its predecessors, from the earliest times of their existence to the present. That is simply because these public agencies have always expressed the response of government to the changing needs of the times in a democracy.

If the various commissioners and secretaries of agriculture had been self-determining promulgators of policies and programs, there would have been, as a matter of course, abrupt shifts and sharp veering changes in course from one administration to the next. As a matter of fact this did not occur. The development of the department's work proceeded as logically and as inevitably in response to the needs of the people voicing their demands as does the growth of a tree in the soil in response to the factors of its environment. The department's growth has been evolutionary, almost biological in nature. It has proliferated naturally, logically and inevitably as a part of the Nation itself. Its present existence in modern streamlined form has made it an invaluable agency in operating the National Defense Program, for it has ready at hand the organization and the machinery to do effectively many tasks which were neglected or were undertaken hastily in emergency set-ups during the World War.

A SKEPTIC AMONG THE SCIENTISTS

By RUFUS SUTER
LIBRARY OF CONGRESS

We live in the age of science. Everything around us has been influenced by her. This holds not only for the tangible objects like running hot and cold water and the Goodyear blimp lit up by electricity which the Washingtonian sees every summer evening, but also for the things of the spirit: the stories projected on the talking moving-picture screen, radio drama and some modern symphonies.

We have grown too accustomed to the miracles wrought by science to think of her for herself. There was, however, two centuries ago a talented devotee of this pursuit.

David Hume we may not remember. If we do it will be as a jolly Scottish bachelor with whom Madame de Pompadour and other of the colorful ladies in the court of Louis XV enjoyed talking. But we may forget that in his youth he wrote "A Treatise of Human Nature," and a few years later "An Enquiry Concerning Human Understanding." In these works he made some remarks of interest to the student of science.

Hume's significance was not grasped in England in his day. His Treatise, as he said, fell "dead-born from the press," and his Enquiry was hardly less unsuccessful. The difficulty was that his researches lay in an impractical direction out of line with the industrial developments to which science was destined. Strange as it seems when we consider the worldly bent of his mind, he worked among images of the fancy, memories and the sensations: emotions, sounds, tastes, odors, feelings of touch and colors spread out in patterns. It would even be misleading to speak of him as a psychologist. The psychologist is fascinated by the same objects, but as constituting one subdivision of nature among many: the content of mind as distinguished for example from chemical compounds. Hume's attitude was different. He confined his attention to what we ordinarily call psychical or mental facts because he was convinced that nothing else was known. It is not remarkable that he was unappreciated by his industrial-minded contemporaries.

From our vantage-ground of the twentieth century, however, we may look back at him and see him in relation to the scientific movement as a whole. We will acknowledge that he was in certain respects more acute than the men remembered as inventors of useful machines.

One occasionally wonders why humanity waited so long before having the good sense to observe and experiment. The truth is this wonderment is based upon an illusion. Observations and experiments have been made since time immemorial, but they were piecemeal and barren. We fail to notice them because the issue of modern science has been overwhelmingly rich. What was slow in dawning upon the human mind was the awareness of a fecund principle of direction for search; and why this twilight endured for centuries will be plain when we recall that the aim sought and finally achieved was the unnatural idea of scanning nature for an utterly de-humanized orderliness, that is, a lawfulness or regularity of event not associated with any quaint human and all too natural conceit.

Once such lines of bare orderliness were unraveled, the question arose: Why do these law-abiding, systematic sequences of happening hold? Galileo's reply is interesting because it is the same as that of any technical student to-day. Forces act in the world (as energy is generated in a gasoline engine); these forces are invisible (as the energy in the motor is invisible), but they are constant, and they cause the regular motions of the parts of nature which we see and touch (as the energy in the engine makes the wheels of the automobile turn).

We wish to emphasize that for science in Galileo's age, as for perhaps most engineers to-day, cause in the sense of unobserved, unobservable, compulsion was all-important.

But now we return to Hume. He made some curious comments about billiard balls in his Enquiry. Under these remarks lies hidden an original undertaking: an attempt to discover the nature not of the effects of cause, but of cause *per se,* by observation and experiment. Hume was merely following in the footprints of his great predecessors. Galileo, applying the empirical method to objects sliding down an inclined plane, had decoded the principle according to which bodies fall; Boyle using the same technique had uncovered the rule concerning gases under pressure; Newton had deciphered the law of gravitation. Why should not Hume by an analogous procedure unearth the true character of *causality* about which philosophers had wrangled for generations but without agreement? We will literally observe, then, a case of causation. Thus the billiard ball experiment.

It is unnecessary to be explicit about the result of this investigation. We can guess it in advance. What Hume saw (and what any of us would see, though we were armed with microscopes and x-ray devices) was that ball A touched ball B and ball B started to move.

This brings us immediately to Hume's premise: Only psychical facts are known. Stated in this bald form his premise seems absurd; but we may restate it: Only observed facts are known. By "observed" is meant "sensed," any by "sensed" being aware through any of the channels of sensible knowledge: sight, hearing, touch, or the like. These two expressions of the premise are equivalent, since what we see are visual sensations, what we hear are auditory sensations, etc.; and sensations are certainly psychical facts. In what else, Hume might ask, can knowledge consist?

Granted this premise, the outcome of the billiard ball experiment is probably irrefutable. If we literally *look* for causation in the sense that Galileo sought for the regularity in the movement of falling bodies, our information will entitle us only to Hume's causal law: A cause is "an object, followed by another, and where all the objects similar to the first are followed by objects similar to the second." This principle is the same in form, and was reached in the same way, as Galileo's generalization that bodies sliding down a smooth, fixed inclined plane move with constant acceleration, which diminishes as the angle of inclination is reduced. The sole difference, aside from subject-matter, is that the former rule is easy of access, while the latter is not evident until the experiment is tried. An analogous statement of Newton's law of gravitation is: Every particle of matter in the universe attracts every other particle, directly as the product of the masses, and indirectly as the square of the distances between them. In none of these rules is recourse had to cause in the sense of invisible force or compulsion.

We will find it amusing to trace briefly some other implications of

Hume's generalization of the empirical method. We may already be persuaded that he was (if an American colloquialism will be pardoned) the original "man from Missouri"; but when we glance at the further steps of his thought we will consider the proverbial Missourian a model of gullibility in comparison with him. Hume did not feel himself justified upon an observational basis in admitting the existence of a substantial world possessing the colors, shapes, smells, etc., exhibited to us by our senses; nor would he acknowledge the existence of minds, souls or persisting self-identical egos, or whatever one wishes to call the agents who have the senses. For Hume reality was a one-dimensional array of observed data. His final position is not unlike that of the Buddhists—a paradox which Thomas Huxley noted many years ago.

It will be worth our while now to catch a bird's-eye view of the Scottish scientist in his setting. There is Galileo who with astonishing insight appreciates that if he assumes the universe to be a machine, and then applies the mechanic's technique of observation and experiment, he will lay bare the regularities of nature. This discovery is followed in rapid succession by the wholesale deciphering of laws. The sciences of mechanics, optics, chemistry, thermodynamics, electro-magnetics, sanitation (to mention only a few) are born. Prediction of natural happenings, and control of nature on a scale never dreamed of by medieval magicians, become really possible. In the end, our industrial civilization with its sky-scrapers and sewers, anesthetics and bombing planes, power-plants and world-wide business organizations come into existence. The picture behind this evolution is, as one would anticipate, practical and severely realistic. The universe consists of tremendous forces. The world is everywhere heavy, powerful, vast, systematic and efficient. It roars along impervious to human foibles, for the delicate entities of the mind play no part in its construction.

We will notice, however, satyr-like Hume winking at this majestic show with its glowering threat of ultimate reality. He has adopted for his own purposes the observational method of Galileo. He insists that since it has been successful in revealing for the first time in history the uniformities of nature it must be the only legitimate instrument for acquiring knowledge. He directs it, therefore, to the inherited, traditional part of Galileo's thought: the uncriticized faith that the universe is a system of regularly acting forces, of efficient causes (to use the Aristotelian terminology). The natural telescope and microscope of the unaided eye he turns upon these alleged beings, and they vanish into thin air. Only moving patches of color remain. The natural calipers, balances, sound-recording devices, etc., of touch and hearing are enlisted. There is a similar dénouement. If observation is the sole road to truth, and if observation does not reveal matter, energy or mind, these must go along with the other Aristotelian fictions into the limbo of medieval myths. Hume outdid his scientific predecessors and contemporaries, and many of our modern investigators, with their own empirical technique. He turned their instrument against them, and whatever gave tangible body to their ways of thinking, and effectiveness for molding the practical future to their purposes, suddenly loomed without a basis.

Hume alone among the scientists appreciated that the attitude which was to give birth to our industrial, mechanical civilization could lead to results incompatible with at least the emotional background—the feeling of the hugeness and metallic reality of a world independent of human consciousness—which could

form a setting for the growth of that civilization. His quizzical demurrer, however, passed unnoticed, and the scientists continued to observe, experiment and build as if he had never lived.

What was the error in Hume's analysis? None of us is persuaded by his dreamy, ultra-critical Buddhism, yet we can not refute him. Two replies are possible. Either the query begs the question, because there was no error; or there are other ways of knowing besides the senses. The former alternative is not without its champions among the scientists to-day. We have our positivists. The advocates of the latter attitude, however, are in the majority, because this is the viewpoint of common sense for those of us whose intellectual atmosphere emanates by way of the medieval schoolmen from Aristotle. The supporters of this latter attitude see the world from the same perspective as did Galileo. He was the first of the moderns, but also in so far as he kept faith with the world of matter, efficient causes and souls he was a transmitter of Aristotelian lore.

We often hear of skeptics among religious and ethical thinkers. Hume was that rare creature, a skeptic among the scientists. He is the precedent for our wondering occasionally, while we use our hot and cold running water and listen to our radio, whether it is possible that these and the other miracles wrought by science are after all the issue of an incomplete or baseless piece of reasoning, on the part of our ancestors, misled by the fragments of Aristotelian lore remaining in their minds, in the sixteenth and seventeenth centuries.

OUR FAVORED LAND

In our favored land, as in all lands, "nothing is happy altogether." We occupy, we waste, we suffer, until one day we discover, and report, and at length discuss the common good. The hope arises that with intelligence and spirit we can one day build in America a *Civitas Dei* out of familiar materials. Statistics are needed for that city as well as hope and faith. Carvers and goldsmiths, cedar and fir, oil and grain are the media of the builders. But over and through all is spirit. This is compounded of faith in the good will and the informed judgment of common people; in the search for and the use of our best not our meanest intelligences; in the university's relentless insistence upon excellence; in scorn of those who put cynicism and cleverness above self-sacrifice; in unremitting concern for the poor; in a lively sense of the social responsibilities attached to the privileged life of scholarship. Justice Oliver Wendell Holmes's remark, "I have labored carefully not to mock, lament, and execrate the actions of men; I have labored to understand them," is a good social text for a university man as for the average citizen.

Some sense of glory there must be too if we would unfix the stars. Here and there must be men of vision who proclaim what America can be: men who cherish the unburied past of heroic deeds and ringing words: ever-remembering men: men flashing the signals of deeds done in high spirit. The university, like the church and the market and the court, must proclaim that only such men are fit for our America. We can foretell that America only if we here and now resolve to make that which we foretell. The land is fit for it if we care for it, our stock is capable, our culture maturing.

O fortunatos nimium sua si bona norint. ("Oh, only too happy if they could know the advantages they possess.")—*Isaiah Bowman in the symposium, "The University and the Future of America," at Stanford University.*

BOOKS ON SCIENCE FOR LAYMEN

PRESERVATION OF WILDLIFE[1]

"WHAT we want is something to shoot at. And we're going to get it if we have to take the old Wyandot rooster out into the woods, turn him loose, and blaze away." This statement, made during recent controversy over quail legislation, represents one segment of the great American public which Dr. Gabrielson serves as director of the Fish and Wildlife Service. The other limit might be symbolized in Cowper's remark that he would not call any man his friend who would needlessly set foot upon a worm.

Between these two extremes, not to forget biological problems and the claims of legitimate economic life, the conservation of animals is no picnic. Throughout this excellent book, it is evident that the author has a wholesome respect for the difficulties of the work to which he is devoting his life. Read thoughtfully, the book is quite as valuable for the insight it gives into the political realities of applied biology as for the scientific information which it contains.

Modestly enough, Dr. Gabrielson announces his purpose in writing the book to be that of putting into simple language some of the basic principles of wildlife conservation. At the outset he emphasizes the fact that all aspects of conservation are but phases of a single problem. He maintains—and demonstrates—that there can be no conservation of wildlife without proper conservation of forests, grassland, soil and water resources. Fundamentally the problem of wildlife production is one of supplying proper environment, with harvest proportioned to reproduction.

In workmanlike fashion the book starts out with a consideration of the cycles of material and energy change which are the basis of life. One may question the validity of distinguishing between renewable and non-renewable resources, except as a matter of convenience. Nothing is less renewable than an extinct species, while chemical technology may, at any time, place the whole periodic table in the renewable class. For instance, it has been estimated that during the process of extracting bromine from sea-water, millions of dollars worth of other substances have been run through the apparatus in the course of some months. Be that as it may, it is good to see the nitrogen cycle set forth as part of a logical structure instead of being dragged in by the heels.

There follows a consideration of the various types of habitat and environmental factors, a statement of ecological principles and a discussion of various types of wildlife. The book concludes with a presentation of practical obstacles.

Dr. Gabrielson appears to limit the province of ecology more sharply than most students of the field, the reviewer included. With Carpenter he holds it to be the study of living communities and the interrelations within them. Plant ecologists are not likely to concur in his description of unbroken forest as virtually a biological desert. His real point, of course, is sound enough—the greater vertebrate carrying capacity of mixed forest and open country.

In his consideration of various classes of animal life he does not by any means confine himself to those yielding a computable return. Yet he amply demonstrates the economic folly of our present condition. His account of waste in the fur industry is appalling, although it was one of the earliest phases of wildlife to be a subject of legislation.

I gather that, for all our need of basic research upon wildlife problems, Dr. Gabrielson would agree that we know

[1] *Wildlife Conservation.* I. N. Gabrielson. Illustrated. xv + 250 pp. $3.50. 1941. The Macmillan Company.

enough to do vastly better than we are now doing. In his final chapter he discusses the obstacles to conservation, listing them under three headings: (1) the shortsightedness of the human race; (2) the tendency to seek panaceas rather than real remedies; (3) the lack of knowledge and understanding.

Under these three seemingly vague generalities, Dr. Gabrielson develops a critique of American culture which any one can understand, and yet no one can resent. He says what intelligent men, both radical and conservative, have been saying. But he says it without a hint of the too frequent doctrinaire billingsgate and "class-angled" cant. He obviously thinks and works in the American idiom, and in the tradition of the best branches of our civil service.

Besides being readable, the book has good pictures and a wealth of concrete examples which will be of interest to a wide reading public.

PAUL B. SEARS

EUGENICS AND HUMAN WELFARE[1]

IN our modern world, with famine, disease and early death at least potentially under control, men are turning in new directions to control the conditions of human welfare. "The attempt to control the reproductive tendencies of large groups of people, now being crudely essayed in almost every European country, is one of these new fields of activity." These attempts, these new conditions constitute a "preface to eugenics," to a new eugenics program less radical, perhaps less exciting than the one older advocates envisioned, but far more soundly based on present scientific knowledge of the interaction of hereditary and environmental factors, of trends in the size and composition of populations and of sociological and psychological aspects of the environment. Nor is the newer eugenics so radical as to stand very little chance of being applied or even considered at present.

From this point of view, Mr. Osborn proceeds to consider first the significance of genetic inheritance in man, especially in determining intelligence, mental disease and physical defect, following it with a comprehensive summary of studies of heredity and environment. Here the studies on the Jukes, Kallikaks and Nams receive but passing mention. "They failed to differentiate between the inheritance of bad genes and the effects of a bad environment handed on from one generation to another. As sociological studies they are of interest. As evidence on heredity they are now generally discredited." It is encouraging to find a judgment of this kind from a eugenicist. The more modern studies lead to the general conclusion that "differences in hereditary potentials for intelligence are widely scattered in different family lines throughout the whole population. In order to sort them out with any accuracy, it will be necessary to equalize or allow for environmental conditions affecting the development of intelligence." Doing this would more effectively reduce the proportion of the very dull than increase the proportion of the mentally superior. Consequently, "the eugenics program must take in the whole population, encouraging some couples to have larger families and others to restrict the size of their families."

The next section of the book summarizes our knowledge of population trends and outlines a population policy. Inasmuch as we must look forward to a stable or declining population before many decades, measures to check too great or too rapid a loss in our numbers seem to be imminent. Such measures should take eugenics into account, encouraging large families among those individuals most responsive to our environment, whereas at present the largest families tend to appear under those social and economic conditions that are

[1] *Preface to Eugenics.* F. Osborn. xi + 312 pp. $2.75. 1940. Harper and Brothers.

least desirable and least favorable to optimum individual development. Differential rates of increase among the various races, regions or socio-economic groups seem of relatively little genetic importance. More to be considered are differences in standards of living and in the capacity to afford children favorable opportunities for development. Extension of birth control to all classes of the population, together with measures to compensate those with large families for the consequent drop in their standards of living, can be included in the steps toward population control. The Swedish system of governmental aid through free services to mothers and children is to be preferred to direct monetary grants to parents, although taxation might be planned so as to help equalize the economic burdens of large family size. This group of measures should promote births in families where they are desired, and it is believed that that will be among those most intelligent and most responsive to their environment. Only in this way can we avoid the eugenic predicament that faces those who would attempt to decide what kinds of persons the future society needs most.

There will be need, too, for altering the western culture pattern of the small family. Various psychological influences might work to that end, in family, school and public service (doctor, minister, nurse, welfare worker). But the radical aspect of the new eugenics lies not in its relation to private life, but rather in its requirement for a change in many existing social and economic forms that produce unequal opportunities for children of different classes and of different-sized families in respect to nutrition, housing, medical care and recreation. Research in many fields is needed to guide eugenic policies undertaking to equalize the environment at a high level.

The eugenic ideal here set forth is truly democratic in character. It lays emphasis on the worth of the individual, on the right of each to an equality of opportunity during his development. Men are not created genetically equal, but we can tell little about their genetic worth without just opportunities for development. Nor will the socially responsive and intelligent citizen rear the largest families until the "dominance of economics over eugenics," to use Muller's phrase, is considerably mitigated. If democracy is anything more than a static political system, anything worth fighting for to-day, it must be because it includes a vision such as this. The book is very timely.

H. Bentley Glass

UNDERSTANDING INSECTS[1]

This is a simple little book, so simple in fact that the reviewer's first impulse was to relegate it to a shelf which houses books that might interest the grandchildren, perhaps. We assume, of course, that the latter learn to read before their nascent intellects transcend the level of the textual material in such books. However, "Introducing Insects" is neither a series of bedtime stories nor is it a "Rollo book." I say the last with qualms, but Webster defines Rollo, and our younger readers should know about him even though they never had him inflicted upon them as a steady educational diet.

Professor Needham indicates that his audience is the ordinary citizen. However, as the first figure in the book represents a small boy disgustedly viewing a wormy apple (many entomologists perjure themselves by calling an insect-infested apple "wormy"), I think he had intelligent juveniles in mind; consequently, the book was submitted to a young man of particularly inquiring mind, just past his eleventh birthday. This boy's reactions indicated a considerable and sustained interest. Whether the material may be sufficiently complete

[1] *Introducing Insects.* J. G. Needham. v + 129 pp. $1.50. 1940. Jaques Cattell Press.

for those who regularly follow the advance of science as set forth in the SCIENTIFIC MONTHLY is difficult for a professional entomologist to judge. Needless to say there is no misinformation, expressed or implied. Also, the author sticks fast to his promise to refer to the insects only by their common names. Consistency in this respect becomes a little forced here and there, especially in several very uncommon vernacular names coined for certain dragon-flies. However, there is nothing which savors of the pedantic souls who discourse on the "confused" flour-beetle (*Tribolium confusum*) or those who make use of the "suspicious hypholoma" (*Hypholoma suspectum*) for the preparation of mushroom sauce.

There are some eighteen sections to the book, some of them relating to particular kinds of insects like dragon-flies, mosquitoes, bees and caterpillars. Others include references to ecological groups, such as carnivorous insects, those that eat woolens and some others that eat our foods. Finally we are told very concisely how to begin an insect collection and how to rear insects.

One recommendation that should be made is to require the reading of this book by prospective questioners before they inquire of poor overworked college professors how to rid the pet cat of fleas, why the elm-leaf beetle will not destroy their parlor furniture or poison their food, and is he sure that the bugs they describe over the telephone are not termites brought into the house by the neighbor's dog. Many such matters could be settled by reference to Professor Needham's little brochure to the satisfaction of all concerned. This in itself is enough to recommend the book to any one who wants a very brief account of insects that will answer some of the more commonly asked questions.

Finally may I be permitted to quote the very last paragraph in the book. Added as an apparent afterthought, it is commonplace, but nevertheless not frequently stressed: "Collection-making has been among the early interests of many a great naturalist. Observation of the ways of insects is a source of pleasure to very many people who love Nature, and who find delight in personal knowledge of her infinite resources."

C. T. BRUES

A FREUDIAN TESTAMENT[1]

IN the present book Dr. Reik, who has long been associated with Freud, gives us a number of personal glimpses into the life of a great man. Little is added that was not known before, though certain features appear in bolder relief. It is divided into 15 chapters that are not particularly related to each other. They are essays on diverse subjects and what binds them together is that they provide an opportunity to discuss some aspects of Freud's life and personality and of psychoanalysis. The first two chapters recite Reik's personal reminiscences of Freud, while the third and fourth chapters discuss some aspects of teaching and training for psychoanalysis. Chapter 5 records a heretofore unrecorded lecture of Freud's analyzing a "Case of Sudden Conviction." Chapters 6 to 9 are perhaps the most interesting chapters as they deal with Freud as a critic of civilization. The chapter on Dostoyevski is most interesting, and here one is surprised to learn that while Freud admired the artist's rich gifts, he had no great personal liking for him. The last chapters from 10 to 15 discuss a number of unrelated subjects, among which the one on Jewish wit strikes the reviewer as being most interesting.

The book, no doubt, is of interest to trained psychoanalysts, who will find in it much food for reflection although perhaps little that they haven't discussed before. No doubt, too, it will reach the

[1] *From Thirty Years with Freud.* T. Reik. xi + 241 pp. $2.50. 1940. Farrar and Rinehart, Inc.

lay groups for whom seemingly the publishers intended the book primarily. Yet the reviewer wonders whether it is a healthy thing for people professionally untrained in analysis to delve into the subject however interesting material it may contribute to other sciences. Psychoanalysis is and fundamentally remains a branch of clinical medicine that has for its purpose the treatment of certain types of illnesses, and in which the lay public should have no more interest than it ordinarily would in otology or surgical orthopedics. The greatest difficulty that a practising psychoanalyst encounters is among the super-intelligent neurotics who came to the office all-knowing, having read all Freud's works, including the four volumes of Collected Papers, and prepared to offer a complete exposition of their neurosis. It soon turns out that such member of the intelligent uses his acquired knowledge as a resistance against treatment and the proofs offered as conscious rationalizations, designed to defeat the analysis. They are the most difficult patients to handle. No one has deplored more than Freud popularization of psychoanalysis, having remarked once: "As science becomes popularized, it becomes degraded."

BEN KARPMAN, M.D.

MEDICINES, NATURAL AND SYNTHETIC[1]

OCCASIONALLY a book comes along which is read through at a single sitting, not out of a sense of duty, but because of sheer interest. Very rarely, a book which might be read at a single sitting is found worthy of closer attention. "Magic in a Bottle" belongs in this latter category.

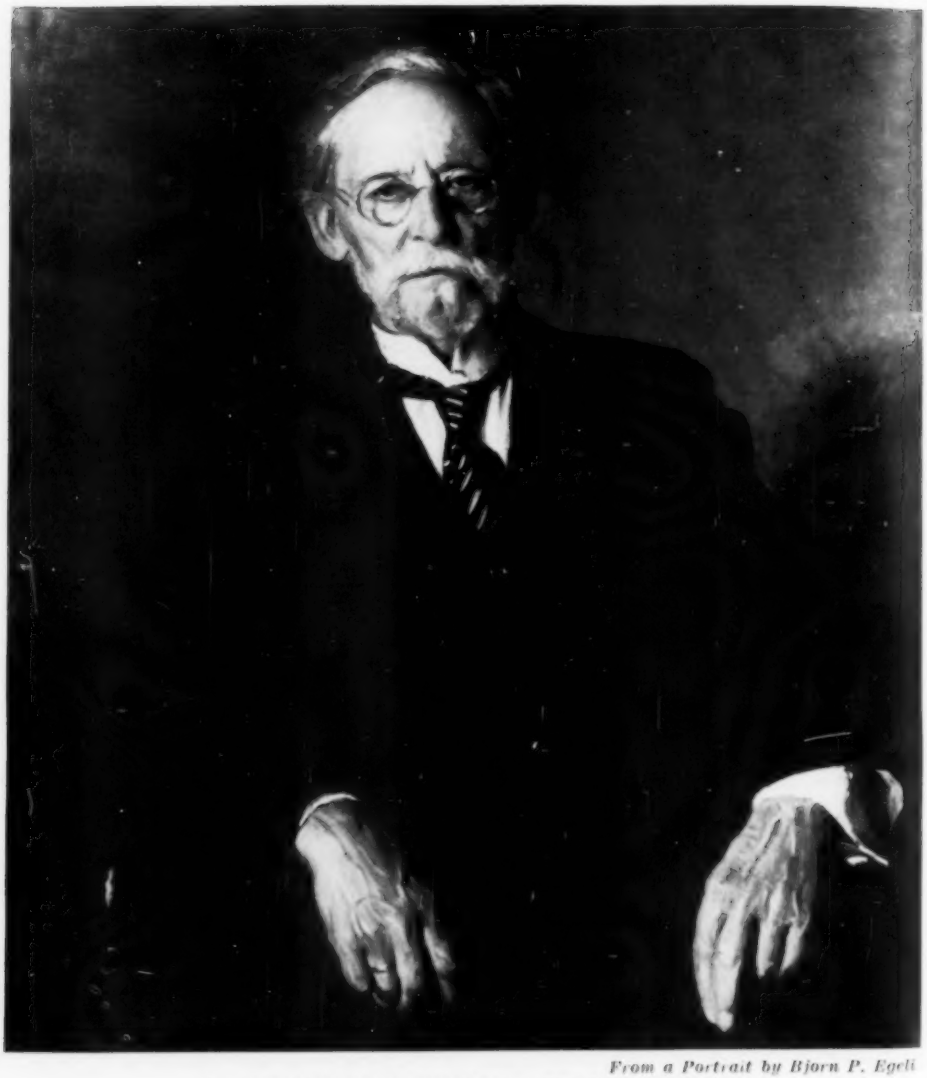
[1] *Magic in a Bottle*. Milton Silverman. xi + 332 pp. $2.50. March, 1941. The Macmillan Company.

Overlooking the title and the publisher's blurb, which smack a little of the "Ain't Nature Wonderful" era of near-scientific journalism, Dr. Silverman's opus may be given virtually unqualified approval. It comprises ten chapters, devoted to the following: Morphine, quinine, digitalis, cocaine, Ehrlich and the beginnings of chemotherapy, antipyretics, hypnotics, vitamins, hormones and finally the sulfanilamide group. Much of the text is based upon rather unusual literature sources, and even the most arrogant specialist will be entertained in spite of himself.

With regard to the layman, the author succeeds, I think, in giving some conception of the situation of the pioneer, surrounded as he is by a lack of knowledge. He makes it clear, for example, how much more difficult it was to discover the first vitamin than all the rest; how extremely difficult it was to recognize the existence of a diet-deficiency principle. He makes clear exactly what Banting and Best did in isolating insulin that nobody else had quite thought of doing. He is to be commended for remarking that when the Nobel prize went officially to Banting and Macleod, and they divided with Collip and Best: "For one time in history, there was enough honor to go around. . . ."

There is an excellent bibliography and an adequate index. Typography is good, with no apparent errors. The spelling of proper names is done with meticulous care, but why the familiar "Sertürner" should be rendered "Sertuerner" is inexplicable. The text is unbroken by any illustration. It seems that at the very least a cut showing Emil Fischer with a test-tube should have been included. And photographs of modern extraction equipment would have been very much in order.

THOMAS B. GRAVE



From a Portrait by Bjorn P. Egeli

DR. LEONHARD STEJNEGER, HERPETOLOGIST

HEAD CURATOR OF THE DEPARTMENT OF BIOLOGY OF THE U. S. NATIONAL MUSEUM, WHO CELEBRATED THE 90TH ANNIVERSARY OF HIS BIRTHDAY ON OCTOBER 30. HE IS A MEMBER OF THE NATIONAL ACADEMY OF SCIENCES AND AN HONORARY MEMBER OF MANY FOREIGN SOCIETIES, AND HAS BEEN A MEMBER OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE FOR FIFTY YEARS. IN SPITE OF HIS ADVANCED AGE, HE MAY BE FOUND ANY DAY AT HIS DESK IN THE U. S. NATIONAL MUSEUM ENTHUSIASTICALLY WORKING ON A MONOGRAPH OF THE TURTLES OF THE NEW WORLD.

THE PROGRESS OF SCIENCE

THE AMERICAN ASSOCIATION MEETS IN DALLAS

For the first time in its history the Lone Star State will be host to the American Association for the Advancement of Science, which will hold its one hundred tenth meeting in Dallas from next December 29 to January 3.

Members of the association who have never been in Texas may think as they board the train for the meeting in Dallas that they are starting for a rugged frontier of civilization. It is true that not many decades ago Texas had ranches almost as large as the smaller of the New England states and was famous for its longhorn steers. But science has made it possible for the world to change rapidly, and most rapidly in an undeveloped region of fabulous potential wealth.

Texas has become an empire, and Dallas is one of its great cities with a population of 350,000. It is not only a large city with fine office and public buildings, and finance and industry and commerce, but it has become a center of culture and education. It justly boasts of the fame of its Little Theatre, of its Symphony Orchestra, of the fact that it is the only city west of the Mississippi River on the itinerary of the Metropolitan Opera Company of New York, of its Civic Center group of fine free museums, including the Dallas Museum of Fine Arts and the Dallas Museum of Natural History, of its Civic Federation, of its great State Fair, of its public schools, the Baylor University College of Medicine and the Southern Methodist University, and of its magnificent parks and large lakes, of its seventeen hospitals, of its 300 churches and of its thousands of attractive homes. Practically all this, and much more, has been created since 1900 when Dallas had only 42,000 inhabitants.

In holding its annual meeting in Dallas, the association recognizes the rapid advances science is making in Texas. Dr. Albert F. Blakeslee will deliver on Monday evening, December 29, his address as retiring president of the association on the subject "Individuality in Science." On the following evening, December 30, Dr. Edwin Hubble, a distinguished explorer of the most distant celestial regions with the great 100-inch telescope on Mt. Wilson, California, will deliver the twentieth annual Sigma Xi address on "The Problems of the Expanding Universe." On Wednesday evening Dr. Christian Gauss, of Princeton University, will deliver the seventh annual lecture under the auspices of the United Chapters of Phi Beta Kappa; and on Wednesday afternoon Dr. Rufus B. von KleinSchmid, president of the University of Southern California, will deliver an address under the auspices of the Honor Society of Phi Kappa Phi.

Thus the association, covering essentially the entire fields of the natural and the social sciences and having over 22,000 members, in the address of Dr. Blakeslee will hold its most formal and distinguished session of the year. The Society of the Sigma Xi, with a membership of over 16,000 men and women who have made notable contributions to science, likewise will hold in Dallas its most important meeting in 1941. For more than fifty years students in American universities and colleges have striven for a uniformly high scholastic record in order to become eligible for election to Phi Beta Kappa. The United Chapters of the Phi Beta Kappa, now with more than 80,000 members, will pay their tribute at Dallas to scholarship in science. Honor

scholars in all fields, through the address of Dr. von KleinSchmid, will recognize the supreme importance of the natural and the social sciences in modern life. In providing these opportunities for scholars from different fields, and with somewhat different primary interests, to meet together, the association serves as an important integrating agency in our complex civilization. These great organizations with large memberships are powerful stabilizing forces in this critical period.

The general addresses which have been listed are only a small fraction of the entire program for the meeting at Dallas. Each of the fifteen sections and the two subsections in medicine through which the association carries on its work will have at least one session for the presentation of papers. The fields of the sections range from mathematics, physics and chemistry through the biological sciences and the social sciences to engineering, the medical sciences and education. The chairman of each of these fifteen sections is a distinguished scientist and a vice-president of the association. Each vice-president will deliver an appropriate general address before the section of which he is chairman.

In addition to the fifteen sections and the subsections on dentistry and pharmacy, thirty affiliated and associated societies and several local societies will join with the association in its meeting at Dallas. Altogether there will be about two hundred sessions for the delivery of addresses and the presentation of papers, the number of which will probably be at least fifteen hundred.

Perhaps an idea of the nature of the scientific sessions can be sufficiently illustrated by the programs of the sections on chemistry and medicine. The chemists will hold sessions through three days at which thirty papers will be presented, and will join in a dinner at which the chairman of the section, Dr. George Scatchard, of the Massachusetts Institute of Technology, will deliver his address as retiring vice-president of the association. The first day will be devoted to a symposium on "Biochemistry," in which

THE CENTRAL QUADRANGLE OF SOUTHERN METHODIST UNIVERSITY
AT THE RIGHT IS DALLAS HALL, WHICH IS THE MEETING HEADQUARTERS FOR SECTIONS IN MATHEMATICS, PSYCHOLOGY AND EDUCATION.

McFARLIN MEMORIAL AUDITORIUM OF SOUTHERN METHODIST UNIVERSITY
WHERE IMPORTANT EVENING LECTURES WILL BE DELIVERED.

eminent specialists will discuss various questions of nutrition, including some of the vitamins. On the second day the program will be on "Spectrographic Analysis," and the third, on "Petroleum Industry," a particularly appropriate subject in the greatest petroleum-producing area in the world.

For nearly ten years the section on the medical sciences has organized symposia on important problems of public health, such as those of cancer, tuberculosis, syphilis, heart diseases and malaria, which have been published by the association. The program of the section at Dallas is on "Relapsing Fever" as it exists among human beings in the United States and in the Canal Zone. Twenty eminent specialists will present papers on this program and it is expected that their contributions will appear as an addition to the series of distinguished volumes the association has published in the field of medical science.

In holding its meeting in Texas, the association is not going to a region without traditions and a long history. More than four hundred years ago, from 1528 to 1536, Francisco Vásquez de Coronado ascended far up its rivers and crossed its broad plains. The first permanent settlement by white men was established at Isleta, on the Rio Grande River, in 1682. Two years later the Frenchman, Sieur de la Salle, descended the Mississippi River from the Great Lakes and founded a colony on Matagordo Bay. With his murder in 1687 the influence of the Spaniards became supreme and remained dominant until Mexico won its independence from Spain in 1821. On March 2, 1836, Texas revolted from Mexico and became an independent republic—this, its Independence Day, still being a state holiday. Finally, in 1845, the Congress of the United States offered statehood to Texas, which the Texans promptly accepted. In spite of its rather stormy early history, its motto is "Friendship" and, indeed, its name is said to be an Indian word for friendship.

It is difficult to realize the extent of Texas, for its area is four times as great as that of all the New England states

THE HALL OF STATE IN DALLAS
HEADQUARTERS FOR THE ANNUAL STATE FAIRS OF TEXAS.

combined and greater than the combined area of all the states, except New York, that border on the Great Lakes. It rises from low, almost tropical areas along the Gulf of Mexico to the fertile prairies of its central part and to the dry staked plains of the northwest. The cotton of Texas is said to be the most valuable crop grown in any political subdivision in the world; indeed, as valuable as the combined production of all the gold, silver, zinc, lead and copper mines of the United States. Texas produces more petroleum than any other state and its petroleum reserves are fabulous, and its natural gas resources are comparable. It was in this land of variety and abundance that John Neely Bryan, in 1841, built a one-room log cabin and started Dallas on its way.

Fortunately Dallas was at the crossroads of migrations from the East to the West and from the North to the far South. It was settled by peoples of various origins and traditions and ambitions. The Spanish influence still lingered, and the French; it was influenced by the old aristocracy of the South, by the industrialists of the Northeast, and by the agriculturalists of the Middle West. Its dreams were influenced by the wide open spaces, and they are being realized. Although it now has big business and is the seat of the Federal Reserve Bank of the eleventh district, it retains the sincere friendliness that has always been characteristic of the American frontier. It is in this interesting region that the association will hold its meeting. And since it is far on the road to Mexico, convenient arrangements are being made for an excursion, for those who desire to take it, to attractive Mexico City and surrounding country.

F. R. Moulton,
Permanent Secretary

CENTENARY OF THE ROYAL BOTANIC GARDENS AT LONDON

In the eighteenth century a Royal Residence, together with certain houses for accommodation of the Court, clustered round the village of Kew, while a level expanse of alluvial soil on the south banks of the Thames offered a favorable site for horticulture in the country air, then relatively pure. From 1772 onwards, a part of this ground had been used for the cultivation and acclimatization of rare and foreign plants, in which certain ladies of the Court were interested; in particular the Princess Augusta of Saxe-Gotha, wife of Frederick, Prince of Wales. This original botanic garden comprised about eleven acres of ground close to the village of Kew, as it then was. It is represented to-day by an area surrounding the director's office, with entrance to the Royal Gardens, now greatly extended, through the Main Gate from Kew Green.

As a private garden the enterprise of 1772 lacked stability. It is true that at times cultivation was active there; but then would follow periods of neglect. Particularly was this so after 1820, when King George III died. For some twenty years thereafter its fate hung in the balance; some even advocated its abolition as a scientific center. But gradually public opinion asserted itself. In a detailed report to government certain competent authorities sketched out the ideal of an Imperial Botanical Service, of which Kew should be the center. Under that scheme Sir William Hooker, then Regius Professor of Botany in Glasgow, was appointed as director. He took up his duties on April 1, 1841, a date which marks the birth of the modern Kew. For nearly half of the century which followed, the fortunes of Kew were guided by Sir William Hooker and by Sir Joseph, his son, who followed him in the office of director. Both were universally acknowledged as leaders in the botanical world of their time, and they have stamped the work thereafter done at Kew with their own scientific seal.

In 1841 Sir William found the garden to be of very limited acreage, and poorly

THE MAIN ENTRANCE OF THE ROYAL BOTANIC GARDENS ERECTED IN 1845

KEW PALACE, BUILT IN 1631

THE PROPERTY WAS ACQUIRED BY KING GEORGE III IN 1781 AND FOR A TIME WAS USED AS A ROYAL RESIDENCE.

equipped. But his own rich herbarium, museum and library supplied what was needful at the time. The course of the century which followed has shown a steady expansion in the area of the garden, which now extends over more than 300 acres. The plant-houses now include very imposing ranges of glass, while the herbarium, library and museums have been notably increased during recent years; but the Hookerian collections form the foundation of them all. The coordinating center of the whole establishment is the director's office, an inconspicuous brick building towards which the imperial interests in botany converge. Here is the focus of administration of the garden with its numerous staff. From it radiates information and advice not only to those at home, but also to the Dominions and Colonies—and to foreign lands as well; for there is an international free-masonry in science which even war does not wholly paralyze.

It would be easy to expand this brief account of the evolution of the great establishment now known by the name of "Kew Gardens," as a scientific institution. But there is also another aspect of it, by which it is familiar to the teem-

IRIS GARDEN AND MUSEUM II

OPENED IN 1848 BY SIR WILLIAM HOOKER WHO USED THE BUILDING FOR "THE ILLUSTRATION OF ECONOMIC BOTANY."

ing populace of London: *viz.*, as a place of joyful and orderly recreation for holiday crowds. It would be well worth while for any student of human nature to take his own holiday with those crowds, and to see for himself the various ways in which the dwellers in London enjoy one of the most attractive scenes that the capital of the Empire can present.

F. O. BOWER, F.R.S.

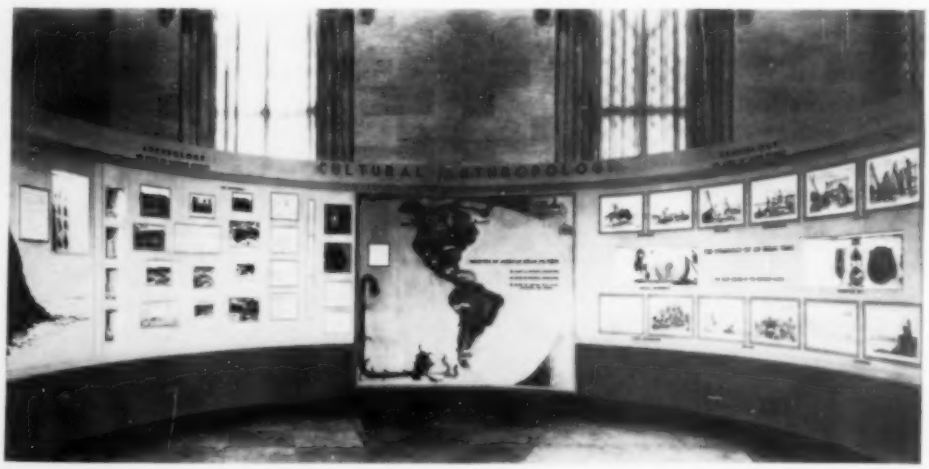
CULTURAL ANTHROPOLOGY SECTION OF THE SMITHSONIAN INSTITUTION'S NEW "INDEX EXHIBIT"

IN the October, 1941, issue of the SCIENTIFIC MONTHLY the exhibition of physical anthropology was described. Adjoining this is a semicircular alcove illustrating the research in cultural anthropology. This phase of anthropology studies man's behavior as a social being and seeks to trace the origin, development, and world variation of human activities, such as social institutions, economics, religion, art and language.

That branch of cultural anthropology which studies the cultural remains left by vanished peoples is *Archeology*. The branch devoted to the study of living groups of mankind, especially primitive peoples, is called *Ethnology*. The exhibits displayed in this alcove illustrate, so far as space would permit and in very general terms, the methods used and limited examples of results obtained from archeological and ethnological research in restricted fields.

These exhibits were prepared by and illustrate the work of the staff in the Department of Anthropology of the U. S. National Museum and the Bureau of American Ethnology.

The left quadrant is devoted to archeology, the study of vanished peoples. On one section of the quadrant is a painting of a cross-section of an Eskimo midden on St. Lawrence Island, Alaska. This painting, together with the actual ivory and bone harpoon heads, illustrates the various changes in shapes and decoration of the harpoons, one element in the Eskimo material culture, over a period of 2,000 years. It also indicates by letters the relative position of the various types as found in the midden from the earliest "Old Bering Sea" type indicated by



CULTURAL ANTHROPOLOGY ALCOVE IN THE "INDEX EXHIBIT"

PANEL ILLUSTRATING VARIOUS ACTIVITIES STUDIED BY ETHNOLOGISTS

"A" at the bottom of the midden to the modern type "E" as used by living Eskimo. It is on the basis of such vertical stratification that archeology determines the relative age of bygone cultures.

Between the Eskimo exhibit and the colored outline map of the western hemisphere are illustrated by means of pottery vessels, photographs of excavated dwellings, charts and sections of wooden beams, the various developmental stages of pueblo pottery, weapons, architecture and clothing from the so-called "Basket-makers" up to modern Pueblos.

VERTICAL STRATIFICATION
IN A PREHISTORIC ESKIMO MIDDEN.

Within the past fifteen years over two hundred prehistoric pueblo ruins in Arizona and New Mexico have been dated by a more accurate method than any other systems of chronology dealing with aboriginal remains. This method is based not on stratification, or extinct records such as the hieroglyphics of Egypt, but on the annual growth rings of certain coniferous trees which, under normal conditions, will produce a new growth ring each year. Fortunately the prehistoric people in the Southwest used wooden timbers in constructing their dwellings, and the arid climate was conducive to their preservation. The section of a yellow pine log in the upper right-hand corner of the alcove was cut in 1940, and the center ring dates back to 1898. The cedar roof timber directly beneath the yellow pine log came from Pueblo

Bonito and has been dated with an outside ring A.D. 1034 ± 10 and a center ring A.D. 840. The master tree-ring chart—an enlarged example is shown to the left of the beams—carries the present tree-ring chronology from A.D. 1939 back to A.D. 11.

In the center of the alcove is a highly colored map of the western hemisphere on which has been outlined the three varieties of American Indian cultures. These varieties are based largely on an intensive agriculture economy encompassing the American Southwest, Mexico, Central America and the Andean region of South America. Two other types of economy are outlined in color based on a marginal agriculture, and on hunting, fishing, and wild plant gathering. Within these areas small illustrations depict various scenes typical of the area.

On the quadrant to the right an attempt was made to show the variety of activities usually encompassed by an ethnologist in the study of a primitive tribe of Indians or a group of people. By means of twelve animated water colors are shown examples of the subsistence, dwellings, transportation, clothing, social organization, religion and language of the Sioux Indians living in the northern Plains. In two recessed boxes, well lighted from behind the alcove walls, are displayed a series of musical instruments and colorful examples of the geometric art from the Sioux Indians.

FRANK M. SETZLER

SEED MECHANICS

WITH a world full of seed-carrying agents: birds, fur-bearing animals, wind, water, not to mention man with his ships, trains and other conveyances, it is fascinating to note that in many plant families, outside help was eschewed; and some or all of the members of these families have developed mechanical tensions which assist in the distribution of their seeds.

The prints which accompany this article show only a few of the types of seed pods which eject their own seeds. Not shown here are representatives of the bean family, whose pods twist into spirals to cast out the seeds, touch-me-not, whose pods collapse, phlox, whose pods burst asunder, and witch-hazel and members of the nettle family which develop tension that pinches out the seeds. Nor the Virginia smartweed, which somehow transfers pressure on the extruding style to a point at the base of the seed where this pressure causes the seed to be cast violently away from the plant.

Shown here are wild chervil (*i*), whose seeds are merely swung from the tips of their wiry stems, and columbine (*b*), whose seeds are swung out of their pods; shepherd's-purse (*c*) whose pods, when ripe, are loosely attached to wiry stems so that any downward pressure will be followed on release by an upward swing that will carry pod, seeds and all up into the air and away on their journey; toothed spurge (*e*) whose seeds are cast away from the plant by a combination of pressure and collapse.

Also shown are some rather more complicated pods. In waterwillow (*a*) the seeds are attached to opposing valves but with their stems crossed so that, when the valves split apart, the seeds are wrenched loose and flung into the air. In pansy violet (*d*) and other violets, the pods first split into three valves and then each valve brings pressure to bear on the enclosed seeds to pinch them out. In toothwoort (*f*) and spring-cress, the valves roll up from the base of the pod, carrying some of the seeds with them. In wild geranium (*h*) the individual seeds are held in pockets at the base of the slender style until dry enough for their stems to come

PLANTS HAVING VARIED METHODS FOR SEED DISPERSAL

free and cast the seed over the top of the pod. Finally, and perhaps the most complicated of all, in the wood-sorrels (*g*) the outer seed coat of each seed turns inside out (inside of the columnar pod) with enough pressure to cast away the seed which it previously enclosed.

Examples could be added, perhaps multiplied. But enough have been given to set any mechanically minded observer to thinking, or even to looking at the plant world with new eyes, eyes that never really saw before.

DAVID S. MARX

HEREDITY AND ENVIRONMENT IN THE SONG OF THE CANARY

PROFESSOR MILTON METFESSEL'S findings on "The Relationships of Heredity and Environment in Behavior"[1] are significant in relation to current articles on human heredity. These findings are based on six years of intensive experiments on the song of the roller canary. Among his principal findings are the following:

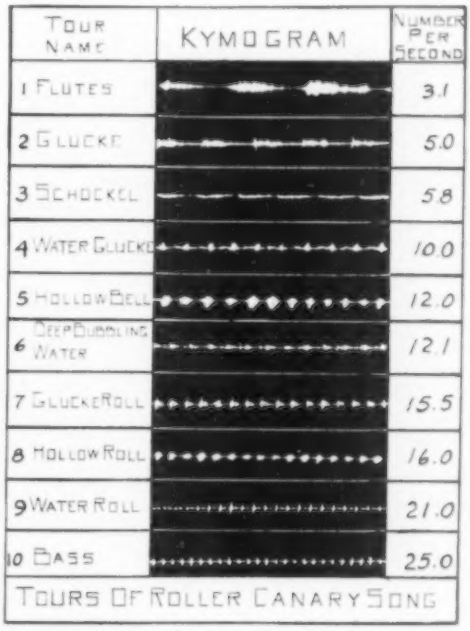
(1) *Heredity.* "Our birds, while still in eggs, were placed in soundproofed cages and were left thus in isolation until the end of the first year of life" (p. 180). "The mature song of rollers consists of tours, of which there are over 20. Tours are somewhat analogous to vowels, consonants and syllables" (p. 181).

The illustration shows ten types of tours, each designated by a name, with indication of the characteristic rate of pulsation. The flutes are the slowest and the bass rolls, the fastest.

Seven male birds were raised in such isolation that they could not hear the song of their species. The problem was to determine whether under these conditions the birds would develop the songs characteristic of the species. Microphones were installed in the cages, and from the time the eggs were hatched, phonograph recordings of a daily sample of the birds' sounds were made. These records are of permanent character and represent a complete series for each bird. Each of the daily records was transcribed into patterns as in the figure on kymograph paper; then each pulsation was counted, and the number of pulsations per second was computed. The findings are based upon readings of 143,297 separate pulsations which were measured.

Metfessel drew the conclusion that "*it was not necessary for a male canary to hear his species song in order to produce it.* The song was a product of his organism. It did not have to be taught, for a canary would learn it by himself "(p. 185). "While the song of the isolated birds resembled that of refined singers of to-day in specific tours, there were other tours which were among those classed by canary fanciers as undesirable" (p. 186). It was believed, from the evidence available, that the song of the isolated birds would be classed as better than that of wild birds and not as good as that of their parents.

(2) *Environment.* Metfessel's next question was, "Can we modify the song of a good mature singer?" To proceed



KYMOGRAPH RECORDS OF THE 10 MOST IMPORTANT TOURS

ONE SECOND OF EACH TOUR IS SHOWN. AS REPRESENTED HERE, EACH PATTERN IS A COMBINATION OF FREQUENCY, AMPLITUDE AND TIMBRE. A PATTERN (OR PULSATION) IS NOT TO BE CONFUSED WITH THE FUNDAMENTAL FREQUENCIES OF BIRD SONG, WHICH VARY BETWEEN 1,000 CYCLES PER SECOND AND 3,000 CYCLES PER SECOND.

[1] *Journal of Psychology*, July 1940, Vol. 10, pp. 177–198.

scientifically, he selected one specific aspect which he proposed to modify; namely, the rate of pulsation, which has at least a very close analogy to the vibrato. It had been shown statistically that the typical singers raised in isolation delivered between two and three per cent. of their songs with a pulsation rate of approximately seven per second. To see whether environmental changes would have any influence on this percentage, he put two birds in isolation cages and delivered to them a musical tone of 1,100 vibrations per second with the vibrato at approximately a half step and a rate of seven pulsations per second. The result was that the song of both birds shifted so that the average of cases at that rate rose from two to thirty per cent. "Both birds learned our machine-made vibrato adequately enough to sound like the stimulus tone to our ears" (p. 189). "These two birds not only added the vibrato to their song, but also changed parts of the species song to conform to their environment" (p. 189). "This experiment supplied a cue to the slight differences found in the song of birds of the same species in different localities" (p. 190).

In another experiment, he substituted a stimulus vibrato of fourteen pulsations for the one of seven pulsations in the preceding experiment. The result of this experiment on four male birds was "Again the expected song of the species was modified by the presence of a specific, stereotyped, tonal environment" (p. 190). Three of the four birds developed a fourteen-pulsation per second vibrato to a significant degree. A similar experiment was made with a vibrato rate of twenty-eight pulsations per second, but this experiment was not completed because one of the males died while it was still in progress.

"Thus, it appears that the organism of a bird can supply both the elements of a song, and a particular combination of elements which can be identified as species song. A specific tonal environment can supply new elements, modify those supplied by the organism alone, and give a new combination of elements" (p. 192).

The author points to a number of biological and sociological implications. To the reviewer, the most significant aspect of these experiments lies in the furnishing of objective data for a biological theory of the vibrato. The interested reader should turn to the original article.

CARL E. SEASHORE

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